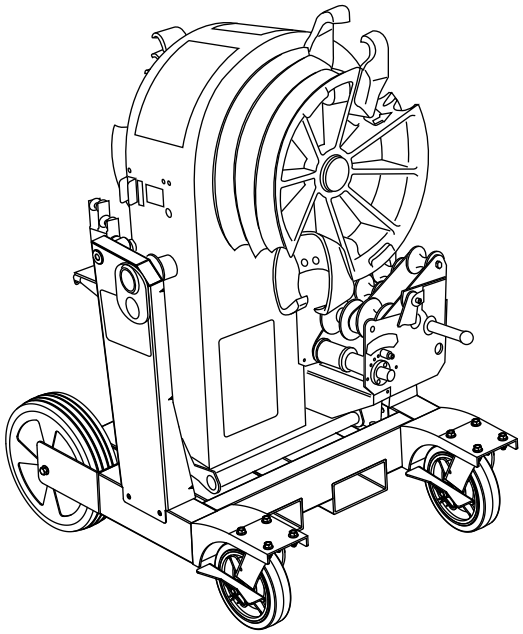
SERVICE MANUAL

GREENLEE®
A Textron Company



855®
Smart Bender®
and 01711 Optional Deluxe Pendant

Serial Code AKN

Read and **understand** all of the instructions and safety information in this manual before operating or servicing this tool.

52033652
© 2007 Greenlee Textron Inc.
11/07

Table of Contents

Introduction 2
Important Safety Information 3–4
Grounding Instructions..... 5
Setup 5–6
Adjustments 7
Maintenance.....8–10
Bender Head Disassembly.....11–12
Motor Disassembly..... 13
Trunnion Disassembly 13
1/2" to 1-1/4" Side Exploded View 14
1-1/2" to 2" Side Exploded View..... 15
1-1/2" to 2" Roller Support Unit Exploded View..... 16
Motor and Gearbox Exploded View and Parts List..... 17
Main Exploded View.....18–19
Main Parts List.....20–21
Electrical Control System Layout and Parts List..... 22
Power Generation Unit Schematic Diagram, Parts List, and Layout Diagram 23–25
Input/Output Board Schematic Diagram, Parts List, and Layout Diagram 26–28
Standard Pendant Switch Schematic Diagram, Parts List, and Layout Diagram 29–30
Optional Bending Attachments Exploded View and Parts List..... 31
Troubleshooting.....32–38

Safety

Safety is essential in the use and maintenance of Greenlee tools and equipment. This service manual and any markings on the tool provide information for avoiding hazards and unsafe practices related to the use of this tool. Observe all of the safety information provided.

Purpose of This Manual

This manual is intended to familiarize authorized Greenlee service center personnel with the safe operation and maintenance procedures for the Greenlee 855 Smart Bender, Serial Code AKN.

Keep this manual available to all personnel.

Replacement manuals are available upon request at no charge at www.greenlee.com.

Other Publications

Instruction Manual: 52033651

All specifications are nominal and may change as design improvements occur. Greenlee Textron Inc. shall not be liable for damages resulting from misapplication or misuse of its products.

Smart Bender is a registered trademark of Greenlee Textron.

Loctite is a registered trademark of Loctite Corporation.

Molex is a registered trademark of Molex Inc.

KEEP THIS MANUAL

IMPORTANT SAFETY INFORMATION

SAFETY ALERT SYMBOL

This symbol is used to call your attention to hazards or unsafe practices which could result in an injury or property damage. The signal word, defined below, indicates the severity of the hazard. The message after the signal word provides information for preventing or avoiding the hazard.

⚠DANGER

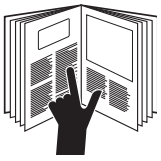
Immediate hazards which, if not avoided, WILL result in severe injury or death.

⚠WARNING

Hazards which, if not avoided, COULD result in severe injury or death.

⚠CAUTION

Hazards or unsafe practices which, if not avoided, MAY result in injury or property damage.



⚠DANGER

Read and understand all of the instructions and safety information in this manual before operating or servicing this tool.

Failure to observe this warning could result in severe injury or death.

⚠DANGER

Do not use this tool in a hazardous environment. Hazards include flammable liquids, gases, or other materials. Using this tool in a hazardous environment can result in a fire or explosion.

Failure to observe this warning will result in severe injury or death.

⚠WARNING

Electric shock hazard:

- Connect the power cord to a 120 V, 20 A receptacle on a ground fault-protected circuit only. Refer to “Grounding Instructions.”
- Do not modify the power cord or plug.
- Inspect the power cord before use. Repair or replace the cord if damaged.
- Disconnect the unit from power before servicing.

Failure to observe these warnings could result in severe injury or death.

⚠WARNING

- Do not expose to rain.
- Do not use in wet or damp locations.
- Do not immerse the pendant switch in water or any other liquid.

Failure to observe these warnings could result in severe injury or death.

⚠WARNING

Wear eye protection when operating or servicing this tool.

Failure to wear eye protection could result in serious eye injury from flying debris.

⚠WARNING

Do not remove guards.

Failure to observe this warning could result in severe injury or death.

IMPORTANT SAFETY INFORMATION

⚠WARNING

Extension cords:

- Use only three-wire, 12 AWG extension cords that have three-prong, grounding-type plugs and three-hole receptacles that accept the tool's plug.
- Do not use extension cords that are longer than 30 m (100').
- Repair or replace damaged extension cords.

Failure to observe these warnings could result in severe injury or death.

⚠WARNING

Pinch points:

Keep hands away from bending shoe, rollers, and conduit when bender is in use.

Failure to observe this warning could result in severe injury or death.

⚠WARNING

Unplug the bender before changing accessories. Accidental startup could result in serious injury.

⚠WARNING

Adjust fork spacing to match fork tubes on bender. Ensure caster brakes are locked and casters are straight before inserting forks into fork tubes. Forks must extend beyond ends of fork tubes a minimum of 8".

Failure to observe this warning could result in severe injury or death.

⚠WARNING

Do not operate the bender while wearing loose clothing. Loose clothing can get caught in moving parts.

Failure to observe this warning could result in severe injury or death.

⚠WARNING

Do not use tool as a step or ladder.

⚠CAUTION

- Conduit moves rapidly as it is bent. The path of the conduit must be clear of obstructions. Be sure clearance is adequate before starting the bend.
- Inspect the bender before use. Replace worn, damaged, or missing parts with Greenlee replacement parts. A damaged or improperly assembled component could break and strike nearby personnel.
- Set the switches to the appropriate conduit size and type before bending.
- Select the appropriate shoe groove and support roller for the type and size of conduit before bending.
- Do not bend conduit over 93 degrees. Overbending could result in the other shoe hook colliding with the conduit.
- Some bender parts and accessories are heavy and may require more than one person to lift and assemble.
- Ensure that all bystanders are away from the work area when operating the bender.
- Ensure that the work area is clean, dry, uncluttered, and well-lit.
- Use this tool for the manufacturer's intended purpose only. Use other than that which is instructed in this manual can result in injury or property damage.

Failure to observe these precautions may result in injury or property damage.

Note: Keep all decals clean and legible, and replace when necessary.

Grounding Instructions

⚠WARNING

Electric shock hazard:

- Do not modify the plug provided with the tool.
- Connect this tool to a grounded receptacle on a 20 A GFCI-protected circuit.

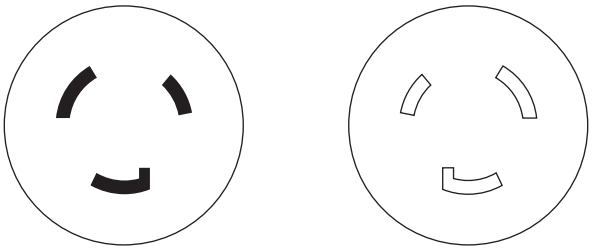
Failure to observe these warnings could result in severe injury or death.

This tool must be grounded. In the event of a malfunction or breakdown, an electrical ground provides a path of least resistance for the electric current. This path of least resistance is intended to reduce the risk of electric shock.

This tool's electric cord has a grounding conductor and a grounding plug as shown. Do not modify the plug. Connect the plug to a corresponding GFCI-protected receptacle that is properly installed and grounded in accordance with all national and local codes and ordinances.

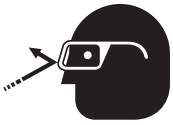
Do not use an adapter.

NEMA L5-20



Plug **Receptacle**

Setup



⚠WARNING

Wear eye protection when operating or servicing this tool.

Failure to wear eye protection could result in serious eye injury from flying debris.

Follow these steps, which are described in greater detail in this section, to set up the bender.

1. Transport the bender to the job site.
2. Lock both swivel casters.
3. Pivot the bending head to the desired position.
4. Connect the pendant to the bending head.
5. Plug the power cord into a 120 VAC, 20 A GFCI-protected receptacle. For best performance, use a dedicated circuit for this unit and do not use extension cords.
6. Turn on the power switch.

Transporting the Bender

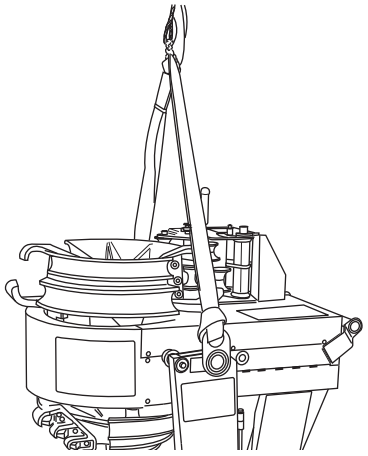
Make sure that all components used to lift the bender are properly rated for the 231 kg (510 lb) weight. Use a ramp to load and unload the bender from a truck or other vehicle that is not equipped with a lift gate.

To roll the bender:

1. Unlock swivel casters.
2. Pivot the bending head to the horizontal position with the 1-1/2" to 2" shoe facing up.
3. Use the transport handle to push and steer the bender.

To lift the bender:

1. Pivot the bending head to the horizontal position with the 1-1/2" to 2" shoe facing up.
2. Rotate the lifting eyes so that they are accessible.
3. Loop the sling (or attach the hooks) to the lifting eyes. Make sure that each side of the sling or chain is 1 m (3') long to prevent it from rubbing against the bender.
4. Securely attach the sling or chain to the lifting device.



Setup (cont'd)

Pivoting the Bending Head

⚠WARNING

- Do not rotate the bending head if one or more of the bending shoes is removed.
- The bender head pivot lock must be fully engaged in the frame hole and fully turned in the counter-clockwise direction.

Failure to observe these warnings could cause the bending head to move rapidly in an unexpected direction, resulting in severe injury or death.

The bending head can be rotated into three positions:

- Vertical
- Horizontal, 1/2" to 1-1/4" shoe facing up
- Horizontal, 1-1/2" to 2" shoe facing up

To change the bending head position:

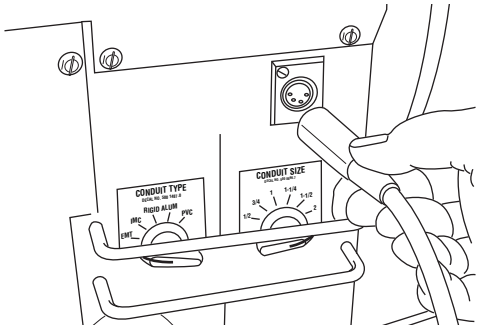
1. Rotate the bender head pivot lock knob clockwise until it contacts the bending head.
2. Pull out the bender head pivot lock knob.
3. Pivot the bending head to the desired position.
4. Release the bender head pivot lock knob so that the pin is fully engaged in the frame hole.
5. Turn the pivot lock knob counterclockwise until there is resistance. Do not overtighten.

Connecting the Standard or Deluxe Pendant

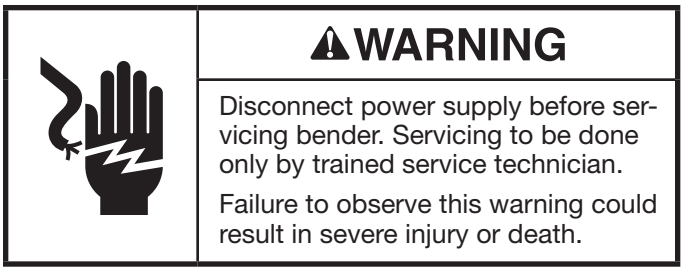
IMPORTANT

Do not connect or disconnect the pendant while the power is on, or permanent damage to the pendant or bender circuitry may result.

Remove the pendant control from its storage area, and plug it into the four-pin receptacle on the side of the bending head.



Adjustments



⚠WARNING

Disconnect power supply before servicing bender. Servicing to be done only by trained service technician.

Failure to observe this warning could result in severe injury or death.

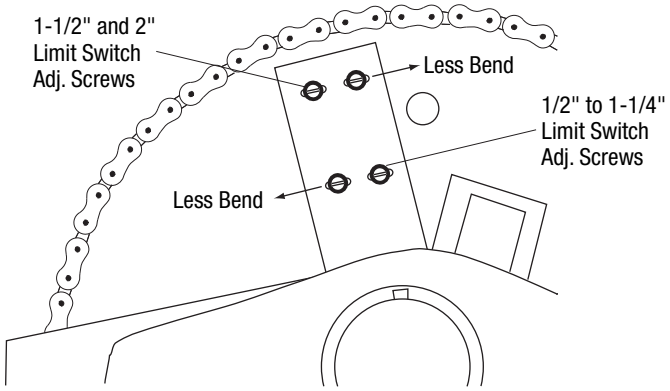
Squeeze

Proper squeeze adjustment for most 1-1/2" and 2" EMT and IMC conduit is when the squeeze adjustment arm is vertical (at middle hole). But variation in conduit can result in wrinkling or side marking of conduit. If wrinkling or excessive ovalness occurs, increase squeeze one position (hole) counterclockwise. If loading conduit is difficult or if excessive side marking occurs, decrease squeeze one position (hole) clockwise.

Accuracy

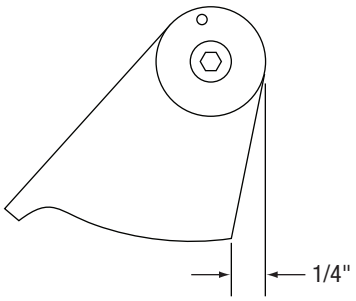
If the accuracy of all sizes of conduit on one shoe is off **in the same direction**, the limit switch needs to be adjusted. Individual adjustments specific to one size and type of conduit should be made using the Accuracy Adjust mode. Refer to the “Troubleshooting” section.

To adjust the limit switches, first unplug the bender. Remove the four screws that secure the top round guard and remove the guard to expose the two limit switches. The top switch controls the 1-1/2" to 2" shoe. Loosen the two screws and move it to the right side of the bender as shown in the diagram below to prevent overbending. The bottom switch controls the 1/2" to 1-1/4" shoe. Loosen the two screws and move it to the left side of the bender as shown below to prevent overbending. Move either switch the opposite direction if the bender is underbending. Every 1/8" of switch movement approximates 1 degree of change. Tighten the screws and replace the guard.

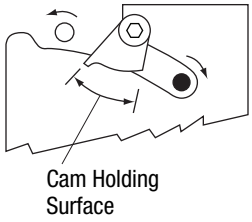


Retention Cam

Loosen the screws securing the retention cam. With the bender oriented in the vertical position, rotate the round plate until the right side edge of the cam is pointed straight down or within 1/4" left of being straight down. Make sure both ends of the spring are engaged in the holes of the cam and round plate. Tighten the screws while holding the round plate in position with pliers to prevent it from rotating.



Check to make sure the roller support handle will fully engage and retract without catching on the cam holding surface. This should be done in both the vertical and horizontal bending positions. It should also be done with the cam positioned as far left and as far right as friction will allow it to stay.



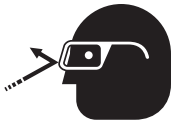
Maintenance

⚠WARNING

Electric shock hazard:

Disconnect the unit from power before servicing.

Failure to observe this warning could result in severe injury or death.



⚠WARNING

Wear eye protection when operating or servicing this tool.

Failure to wear eye protection could result in serious eye injury from flying debris.

Schedule

Component	Maintenance Activity	Maintenance Interval
Chain	Lubrication and Tension Adjustment	Every 6 months*
Roller Supports	Cleaning and Lubrication	Every 6 months*
Commutator Brushes	Replacement	When drive unit performance diminishes noticeably

* More often if the bender is used in dusty or corrosive environments

Chain Lubrication and Tension Adjustment

1. Disconnect the bender from the power source.
2. Refer to the “1-1/2" to 2" Side Exploded View.” Remove the 1-1/2" to 2" shoe (refer to “Changing Shoes” in this section of the manual).
3. Refer to the “Main Exploded View.” Remove the screws (23) and front chain guard assembly (4).
4. Spray a motorcycle chain lubricant on the inside of the chain between the sprockets while pressing **UNLOAD**. Lubricate the entire length of the chain.
5. Check the amount of slack halfway between the sprockets. If the chain slack is :
   - More than 25 mm (1"), proceed to step 6.
   - Less than 25 mm (1"), proceed to step 10.
6. Remove 11 screws (23) and the motor guard (5).
7. Loosen the two motor mounting screws (25) on the front, the two on the back, and the nut (22).
8. Torque the eccentric locator (21) to 81 Nm (60 ft-lb). Maintain this amount of torque while tightening the nut (22) and two front screws (25).
9. Tighten the two rear screws (25).
10. Assemble in reverse order.

1/2" to 1-1/4" Roller Support

1. Disconnect the bender from the power source.
2. Remove the support pivot pin (19). Remove the roller support (7).
3. Spray a motorcycle chain lubricant through the 3 mm (1/8") diameter hole in each roller. Rotate each roller to distribute the lubricant.
4. Spray the pivot pin.
5. Wipe away any excess lubricant.
6. Replace the roller support and pivot pin.

Maintenance (cont'd)

1-1/2" to 2" Roller Support

1. Disconnect the bender from the power source.
2. Remove the 1-1/2" to 2" shoe (refer to "Changing Shoes" in this section of the manual).
3. Refer to the "1-1/2" to 2" Roller Support Unit Exploded View." Use a pair of needle-nose pliers to disconnect the springs (104) from the holes in the side of the bender frame beneath the roller support unit.
4. Refer to the "Main Exploded View." Remove the squeeze adjustment arm screw (97) and arm (74).
5. Remove the three button head cap screws (96) and adapter sleeve (92).
6. Place one hand under the support arms (71) to support the weight of the roller support unit. Remove the eccentric shaft (91).

   Note: You may need to rotate the eccentric shaft to remove it.

⚠WARNING

Pinch points:

Keep hands away from bending shoe, rollers, and conduit when bender is in use.

Failure to observe this warning could result in severe injury or death.

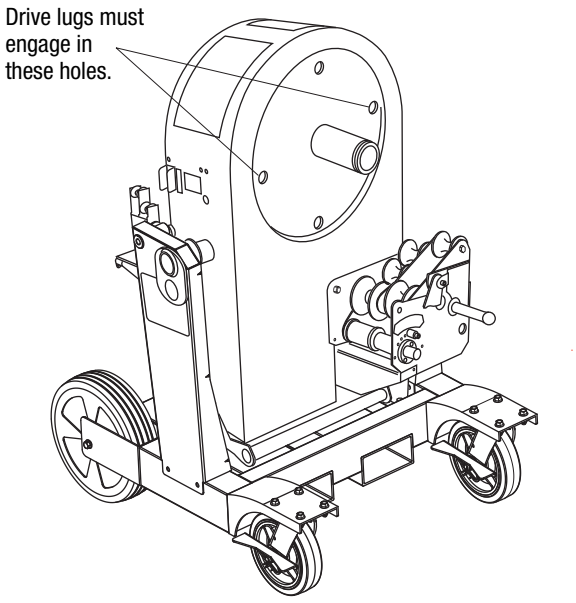
7. Lift the roller support subassembly to the left and upward.
8. On the 1-1/2" roller group:
   - Loosen the sleeve set screw (98) and remove the 1-1/2" pivot roller shaft (86) with grip (90). Remove the sleeve (87).
   - Remove two hex head screws (93). Remove the outer roller plate (75).
   - Remove the tail roller (84).
   - Remove all components of the split roller assembly.
9. On the 2" roller group:
   - Loosen the sleeve set screw (98) and press out the 2" pivot shaft (88). Remove the sleeve (89).
   - Remove the hex head screw (93). Remove one retaining ring (95) from the tail roller shaft (83). Remove the outer roller plate (76).
   - Remove the tail roller (82) and center roller (85).
   - Remove all components of the split roller assembly.
10. Clean off all of the grease and dirt.
11. Inspect each item. Replace any worn, damaged, or missing items.
12. Lubricate all working surfaces with a high-quality grease.
13. Replace all components in reverse order, noting the following:
    - On both roller groups: To ease the assembly of the split roller subassemblies, begin by slipping the O-rings onto the side plates. Assemble the split roller subassemblies as shown, and then slip the O-rings into their correct positions.
    - On the 2" roller group only: After replacing any split roller components, add or remove shim washers (99, 119, or 150) as needed.
    - On the 1-1/2" roller group: Install the two Belleville washers (100) so that the inside diameters contact each other.
    - Use Loctite® 271 on the two hex head screws (93). Torque to 55 Nm to 61 Nm (40 ft-lb to 45 ft-lb).
14. Position the roller support arms (71) as shown. Assemble the roller groups to the support arms.
15. Reinstall the roller support unit to the bender. Keep one hand under the support arms so they do not drop completely below the set screw (107).
16. Insert the eccentric shaft (91).

    Note: You may need to rotate the eccentric shaft to get it to seat completely.
17. Install the adapter sleeve (92) and three button head cap screws (96).
18. Install the adjustment arm (74) and adjustment arm screw (97).
19. Attach the springs (104) to the holes in the side of the bender frame beneath the roller support unit.
20. Put the bender in the horizontal bending position. Adjust the set screw (107), if necessary, so that the support arms (71) are centered between the front and back plates. Engage and disengage the roller support unit to be sure that it moves freely.

Maintenance (cont'd)

Changing Shoes

1. Disconnect the bender from the power source.
2. Lock the bender head in the vertical bending position (refer to "Pivoting the Bending Head" in the "Setup" section of this manual).
3. Refer to the "1/2" to 1-1/4" Side Exploded View" or the "1-1/2" to 2" Side Exploded View." Use heavy-duty retaining ring pliers to remove the retaining ring (26) that secures the shoe.
4. Remove the shoe from the spindle.



5. Mount the replacement shoe onto the spindle. Align the slot in the shoe bore with the screw head on the spindle. Push the shoe onto the spindle until the drive lugs are fully engaged in the drive lug holes. Replace the retaining ring.

Motor

The motor commutator brushes should last for about 1000 hours of normal use but will eventually need to be replaced.

1. Disconnect power to the unit.
2. Remove the motor cover.
3. Remove the power cord strain relief.
4. Remove the two nuts securing the shroud to the tail of the motor and remove the shroud.
5. Push in the commutator brush retainer and move it toward the brush to release it. Unplug the brush and remove it. Replace it if the length is less than 1/4".
6. Reassemble in reverse order.

Setting Roller Support Limit Switch

The switch is activated by the main outer roller support arm, in the retracted position. Retract the switch from the maximum switch travel by pivoting the switch in its mounting holes and rotating it clockwise in its mounting slot.

Set the squeeze adjustment at the maximum clockwise position. Move the switch in a counterclockwise direction (with a 0.030" feeler gage between the roller arm and the body). When the roller, arm, gage, and switch body are in contact, tighten the mounting screws.

The switch lockout circuit is normally closed. Attach alligator clips to the common and normally closed switch terminals to check switch trip operation.
Do not insert meter probes into the Molex® plug.

Brake

Under normal circumstances the brake should not require adjustment. However, if the brake can be heard dragging while bending or if the braking performance deteriorates, brake adjustment may be necessary.

⚠WARNING

Do not touch the brake if the bender has been recently used. It will be hot. Wait an hour for it to cool off before adjusting.

1. Disconnect power to the unit.
2. Remove the motor cover.
3. Loosen the two set screws on the brake rotor hub (the part that turns).
4. Slide it to a position 0.002" to 0.015" away from the mating face (about 1 to 3 page thicknesses of this manual).
5. Tighten the set screws to 4 Nm (35 in-lb).
6. Replace the motor cover.

Bender Head Disassembly

⚠WARNING

Disconnect power supply before servicing bender. The bender head should be serviced/disassembled while on the trunnion base.

Failure to observe this warning could result in severe injury or death.

Electronics

Note: Refer to the "Electrical Control System Layout and Parts List" for the location of key numbers.

Power Generation Board (PGU)

1. Remove the four screws securing the top round cover, and remove the cover.
2. Disconnect the ground jump wire (28) and the white and black leads of the Power AC Wire Unit (21).
3. Disconnect the power cord neutral (white) wire (3).
4. Disconnect the power lead (black) from the switch (1).
5. Disconnect the PGU-I/O cable (13).
6. Disconnect the motor leads (2).
7. Remove the four screws securing the PGU subplate and remove the assembly.
8. Assemble in reverse order, noting the proper polarity of all wires as shown.

Rectifier

1. Remove the PGU subplate by following steps 1 to 7 under "Power Generation Board" disassembly above.
2. Disconnect the red, black, and two yellow wires to the rectifier (18, 19, 20).
3. Remove the screw, lock washer, and nut securing the rectifier.
4. Assemble in reverse order, using heat transfer grease between the rectifier and subplate.

Relay

1. Remove the PGU subplate by following steps 1 to 7 under "Power Generation Board" disassembly above.
2. Disconnect the red and black PGU-relay wires (11, 12).
3. Disconnect the relay wire unit (8).
4. Remove the red and black relay wires (9, 10).
5. Remove the two screws, lock washers, and nuts, and then remove the relay.
6. Assemble in reverse order.

Input/Output Board (I/O)

1. Remove the four screws securing the top cover and remove the cover.
2. Disconnect the receptacle unit (4).
3. Disconnect the selector switch (22).
4. Disconnect the unload lockout switch (7).
5. Disconnect the limit switch (5).
6. Disconnect the optical encoder (23).
7. Disconnect the brake wire (6).
8. Disconnect the PGU-I/O cable (13).
9. Disconnect the Power AC Wire Unit (21).
10. Remove the four screws securing the I/O subplate and remove the assembly.
11. Assemble in reverse order, noting the proper polarity of all wires as shown.

Chain

If the chain breaks, replace it with new chain (90542509)—not another master link. Because of the high stress on the chain, the addition of a second master link will only weaken the chain further. If the master link breaks, replace it with a new master link (90542517).

1. Remove the four screws securing the top cover and remove the top cover.
2. Remove the 1-1/2" to 2" shoe (refer to "Changing Shoes" in the "Maintenance" section of this manual).
3. Remove the seven screws securing the front guard and remove the guard.
4. Remove the nine screws securing the motor cover and remove the motor cover.
5. Rotate the motor until the chain master link is accessible at the top of the bender.
6. With the bender head in the horizontal position, loosen the four bolts and nut securing the motor and turn the eccentric adjusting bolt to allow chain slack.
7. Tap the motor toward the spindle to slack the chain, taking care not to allow the encoder to contact the frame.
8. Remove the cotter pins, master link, and chain.
9. Reassemble in reverse order, noting the following:
   - Torque the eccentric adjusting bolt to 81 Nm (60 ft-lb) while tightening the two front bolts and nut to maintain chain tension.
   - Use a new master link and cotter pins.

See Electrical Control System Layout for location of key numbers.

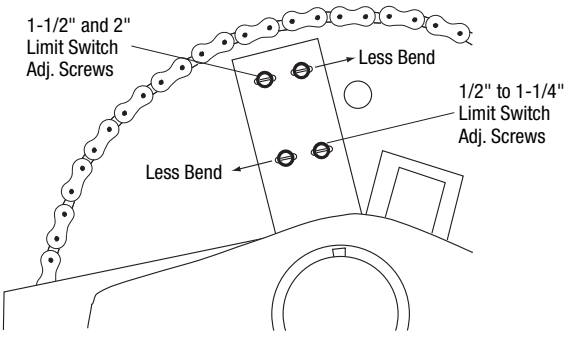
Bender Head Disassembly (cont'd)

Spindle

1. Remove the chain (refer to "Chain" disassembly).
2. Remove the 1/2" to 1-1/4" shoe (refer to "Changing Shoes" in the "Maintenance" section of this manual).
3. Loosen the 1/2" to 1-1/4" drive plate hub set screw.
4. Remove the socket head screw in the 1/2" to 1-1/4" spindle.
5. Remove the drive plate and key.
6. Use a file to remove any raised edges from the spindle to prevent bearing damage.
7. Remove the spindle/sprocket.
8. Reassemble in reverse order.

Limit Switch Bracket

1. Remove the spindle (refer to "Spindle" disassembly).
2. Remove the four screws securing the two limit switches, and remove the switches.
3. Remove the two screws securing the bracket and remove the bracket.
4. Reassemble in reverse order, noting the following:
   - The limit switch with red wires goes on top.
   - Install the top switch so that the trip roller is as far left as possible, as viewed with the switch behind the bracket.
   - Install the bottom switch (black wires) with the trip roller as far right as possible, as viewed with the switch behind the bracket.
   - Temporarily install both shoes before installing the chain.
   - Place 2" IMC in the bender and rotate the shoe until the conduit locks up against tail roller. (**Do not** raise the support rollers as is normal for IMC.)
   - Slide the top limit switch until the contacts trip and tighten in that position.
   - Place 1/2" rigid in the bender and rotate the shoe until the conduit locks up against the support roller.
   - Slide the bottom switch until the contacts trip and tighten in that position.
   - Rotate the spindle, checking that the limit switch trip bolts do not snag the trip rollers. Readjust the bracket mounting, if necessary.



Brake

1. Remove the eleven screws securing the motor cover, and remove the cover.
2. Loosen the two set screws securing the brake rotor, and remove the rotor.
3. Remove the power supply leads.
4. Remove the four screws securing the brake housing, and remove the housing.
5. Reassemble the brake housing and power leads.
6. Use shims to set the brake rotor gap at 0.002" to 0.015" and tighten.
7. Replace the motor cover.

Optical Encoder

1. Remove the four screws securing the top cover, and remove the cover.
2. Remove the seven screws securing the front guard, and remove the guard.
3. Remove the nine screws securing the motor cover, and remove the cover.
4. Rotate the motor until both hub set screws are accessible.
5. Loosen the two set screws in the drive hub.
6. Unplug the encoder from the I/O board.
7. Remove the two mounting screws and round plastic spacers securing the encoder, and pull off the encoder.

   Note: Attach a wire or string to the encoder plug at the I/O board to serve as a retrieval line to pull the new wire and plug up through the unit.
8. Reassemble in reverse order, noting the following:
   - Torque the hub set screws to 0.16 Nm (22 in-oz).
   - Jog the motor and check Quad 1 and Quad 2 LEDs for on/off pulsing.

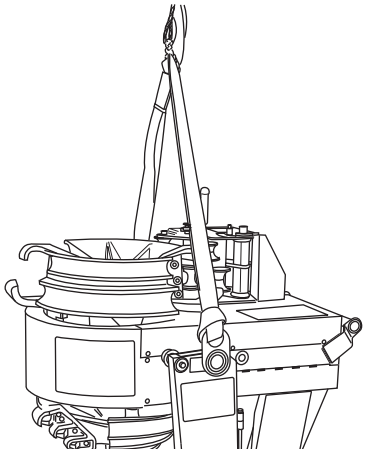
Motor Disassembly

1. Remove the optical encoder (refer to “Optical Encoder” disassembly in the “Bender Head Disassembly” section).
2. Remove the chain (refer to “Chain” disassembly).
3. Remove the brake (refer to “Brake” disassembly).
4. Loosen the motor sprocket set screws, and remove the sprocket and key.
5. Disconnect the motor leads at the relay and the ground wire.
6. Remove the five motor mounting bolts and nut.
7. Remove the motor.

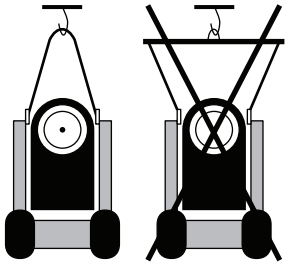
   Note: Attach a wire or string to the motor leads at the power generation board to serve as a retrieval line to pull the new wire through the unit.
8. Assemble in reverse order.

Trunnion Disassembly

1. Support the bender’s entire weight, which is approximately 230 kg (500 lb), at the lifting eyes, but do not lift above the floor.



Note: Lifting slings must attach to the lifting mechanism within the width boundaries of the bender to prevent the lifting eyes from sliding off once the retaining rings are removed.



2. Remove the support tower on the rotary selector switch side.
   - Remove the two bolts and two nuts at the side of the tower.
   - Remove the outer retaining ring on each side of the bender.
   - Slide the tower off the pivot spindle.
3. Slide the remainder of the trunnion assembly off the opposite pivot spindle.

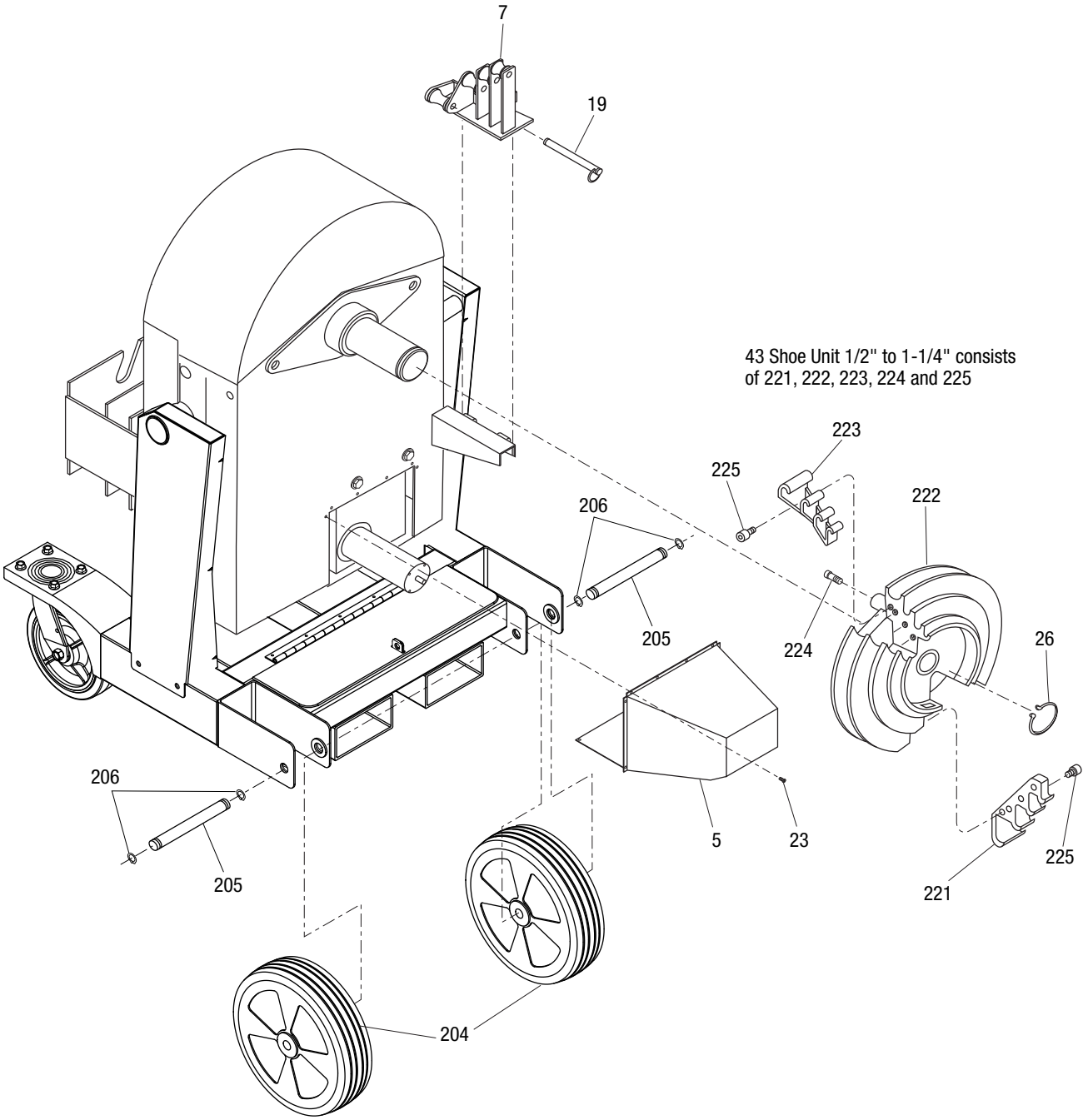
⚠CAUTION

Bender head may rotate a bit when locking detent pin is disengaged. Keep hands clear.

4. Remove the remaining support tower from the base.
5. Pull out the detent pin, knob, and spring.
6. Remove the four bolts and swivel casters on each side.
7. Remove the stationary wheels.
   - Remove the retaining rings on the axle.
   - Press out the axle.
   - Remove the wheel and washers from each side.
8. Assemble in reverse order, but leave out the detent pin, knob, and spring. After all else is assembled, rotate the bender head so that the top of the bender is pointed toward the kickstand, and insert the detent pin assembly. Hold the detent pin in while rotating the bender head back to one of its normal positions.

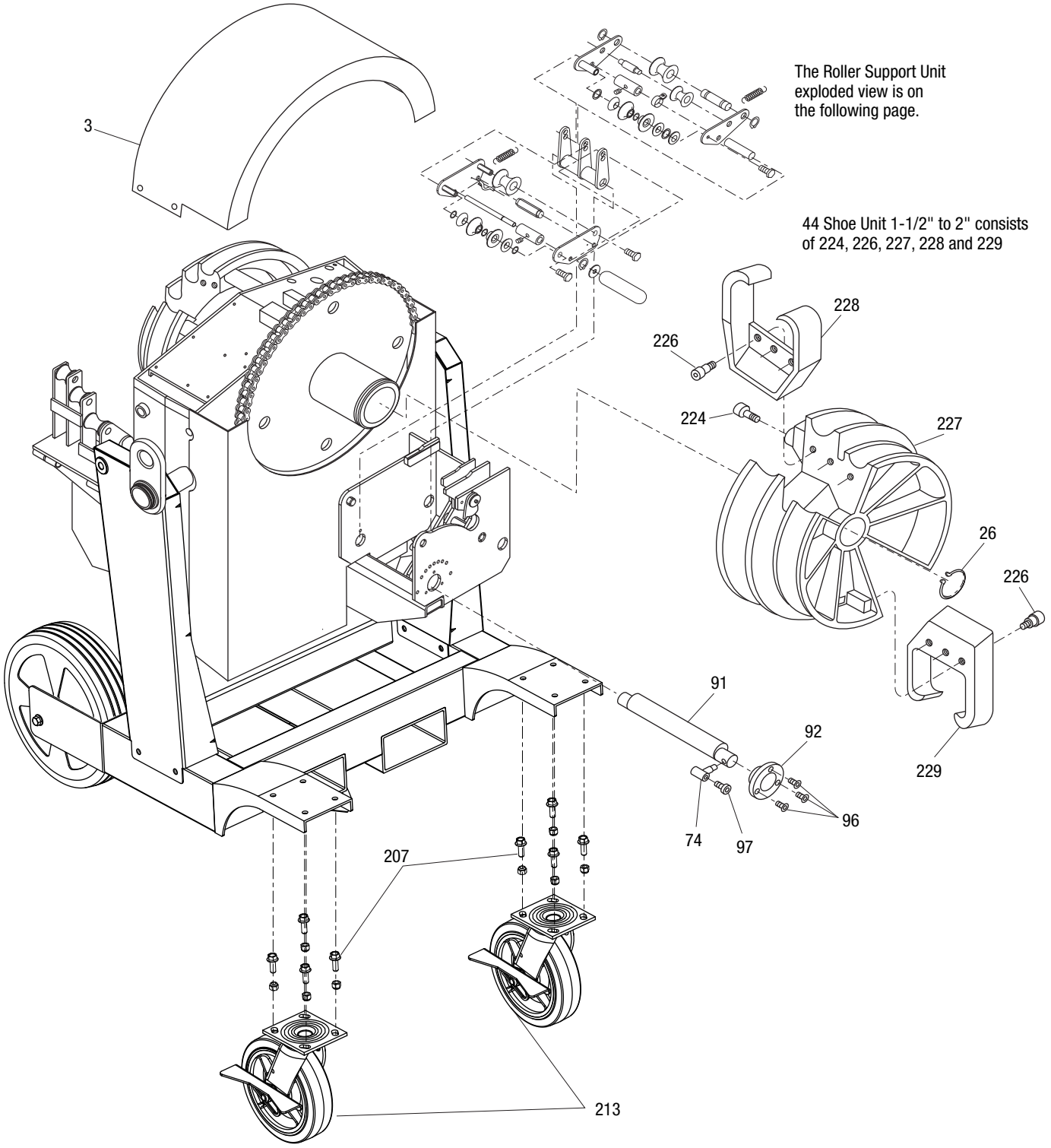
1/2" to 1-1/4" Side Exploded View

Note: Refer to the "Main Parts List" to identify the parts in this illustration.



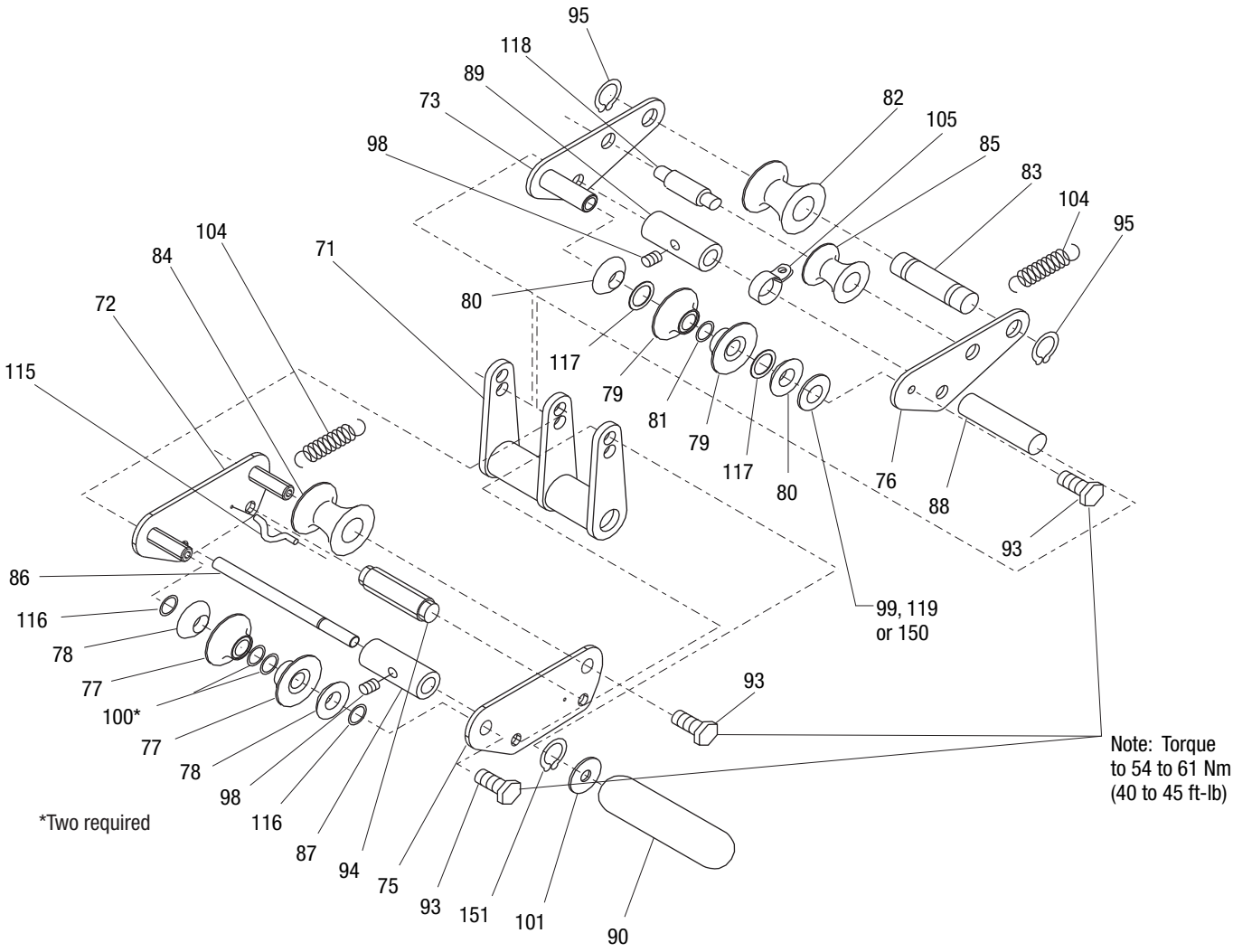
1-1/2" to 2" Side Exploded View

Note: Refer to the "Main Parts List" to identify the parts in this illustration.

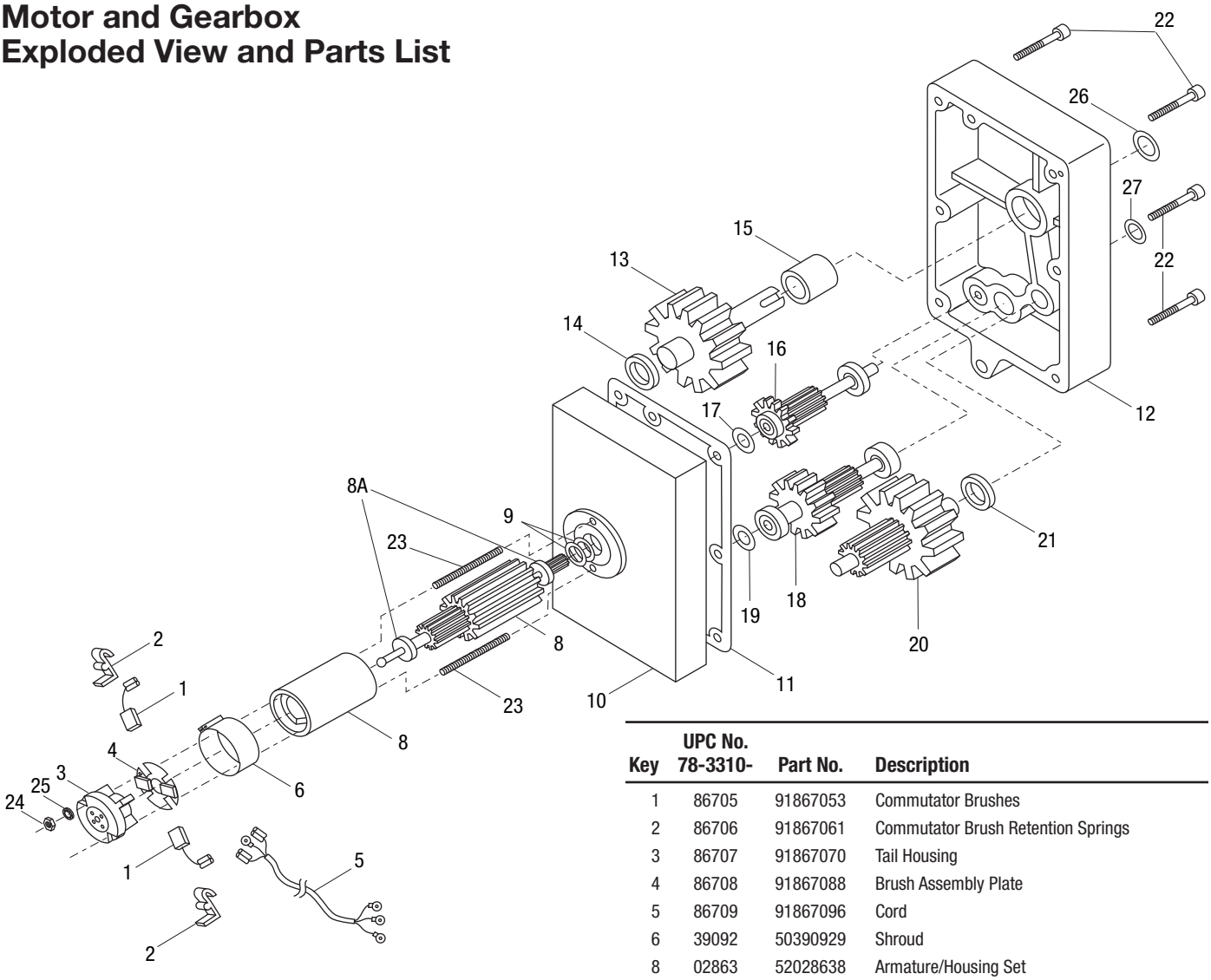


1-1/2" to 2" Roller Support Unit (50005740) Exploded View

Note: Refer to the "Main Parts List" to identify the parts in this illustration.

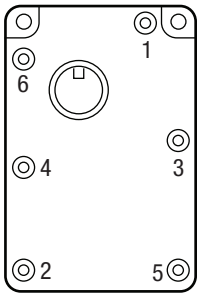


Motor and Gearbox
Exploded View and Parts List



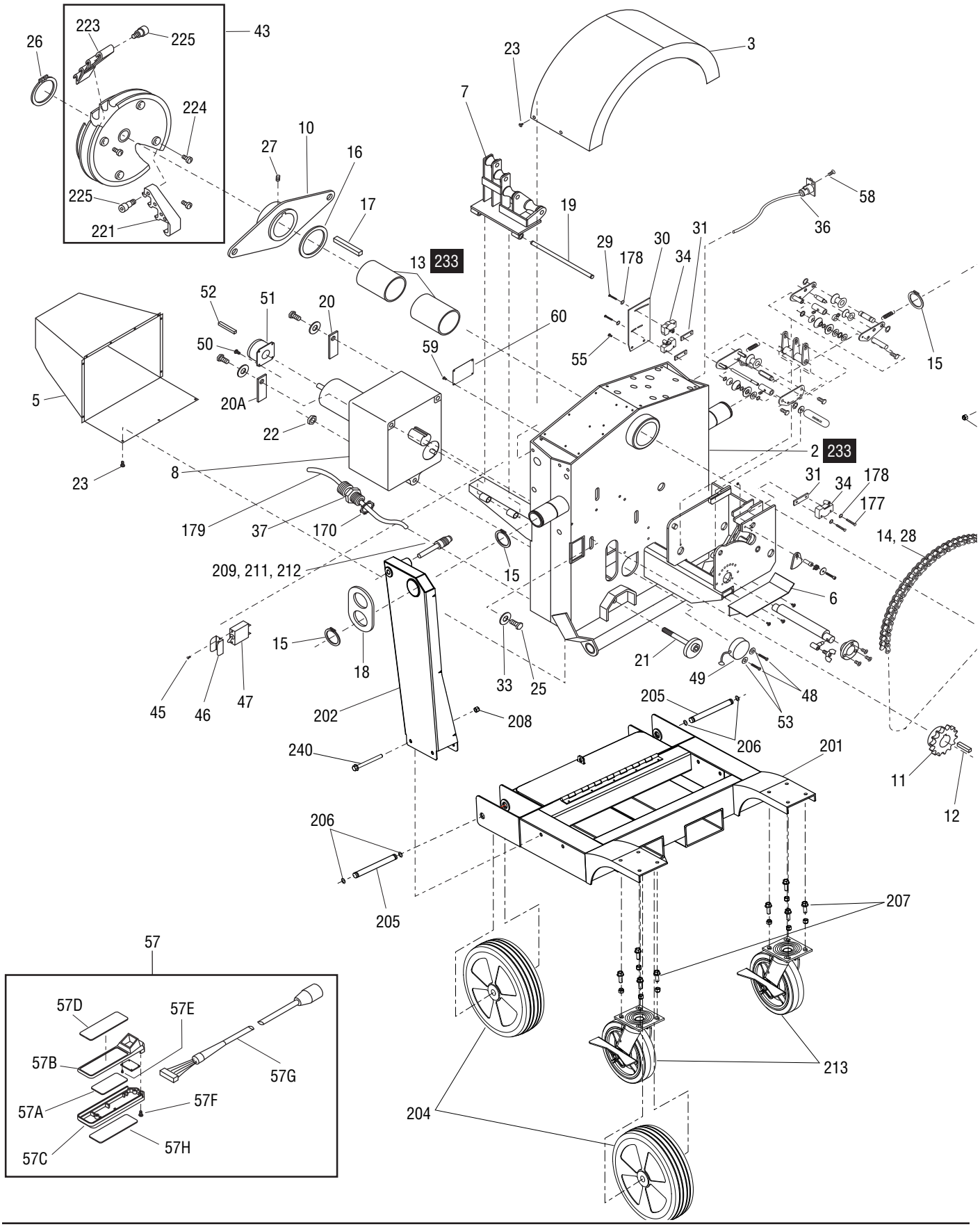
Key	UPC No. 78-3310-	Part No.	Description
1	86705	91867053	Commutator Brushes
2	86706	91867061	Commutator Brush Retention Springs
3	86707	91867070	Tail Housing
4	86708	91867088	Brush Assembly Plate
5	86709	91867096	Cord
6	39092	50390929	Shroud
8	02863	52028638	Armature/Housing Set
8A	86071	91860717	Bearing
9	54348	90543483	Belleville Washers
10	39073	50390732	Rear Gear Housing
11	39074	50390740	Gasket
12	39075	50390759	Front Gear Housing
13	39076	50390767	Output Gear Shaft
14	39077	50390775	Short Spacer
15	39078	50390783	Long Spacer
16	39079	50390791	2nd Reduction Pinion Shaft w/ BRGs
17	53323	90533232	Wave Washer
18	39080	50390805	3rd Reduction Pinion Shaft w/ BRGs
19	54248	90542487	Belleville Washer
20	39081	50390813	4th Reduction Pinion Shaft
21	39082	50390821	Small Spacer
22	54043	90540433	1/2-20 x 2-1/2 Screw
23	02298	50022989	1/4-28 x 9-1/4" Stud
24	51705	90517059	1/4-28 Hex Nut
25	50749	90507495	1/4" Internal Tooth Lockwasher
26	07208	50072080	Oil Seal
27	07209	50072099	Oil Seal

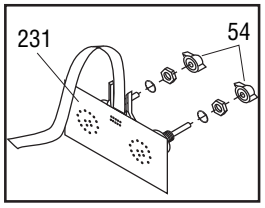
Bolt Tightening Sequence for Gearbox Cover

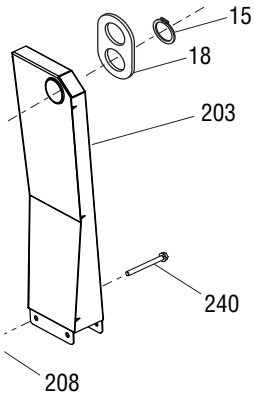


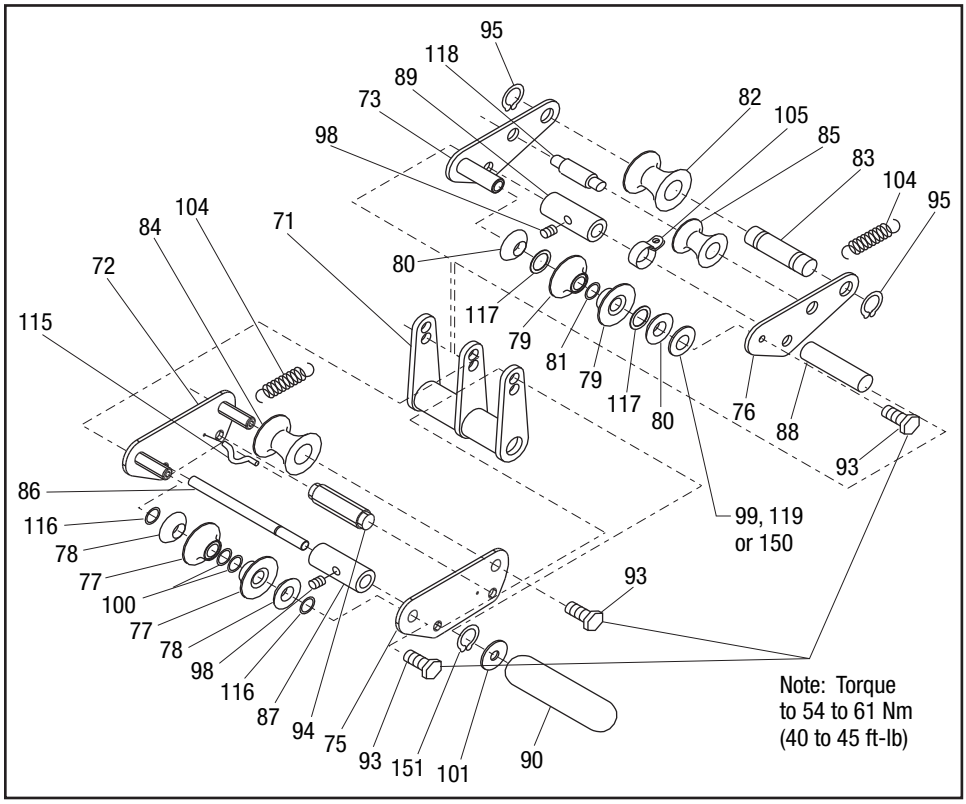
1. Torque gearbox bolts to 11/9 Nm (100/80 in-lb) in sequence shown.
2. Assemble all Belleville washers so that I.D.'s butt and O.D.'s contact bearings.
3. Tighten motor nuts (24) to 3/4 Nm (30/35 in-lb).
4. Insert commutator brushes before connecting push-on terminals.

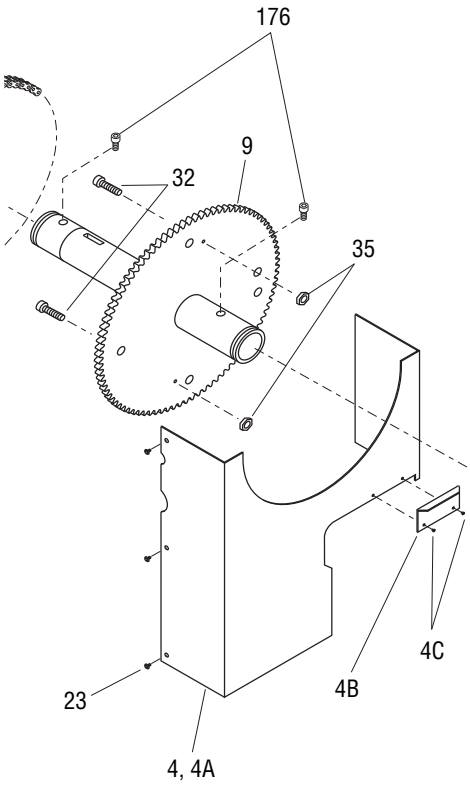
Main Exploded View

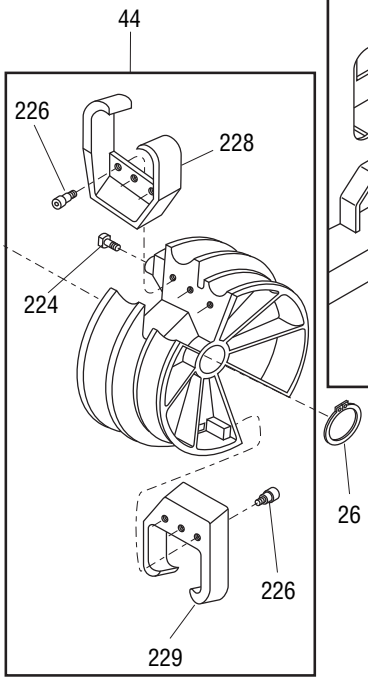


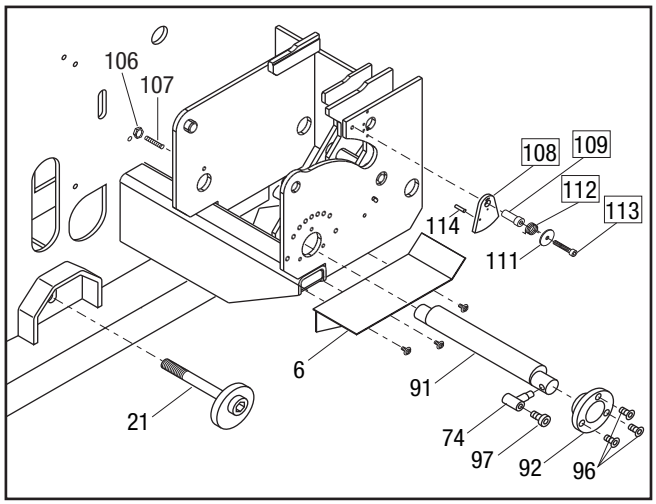












☐ = Cam Repair Kit (50079395)

If the chain breaks, replace it with new chain (90542509)—not another master link. Because of the high stress on the chain, the addition of a second master link will only weaken the chain further. If the master link breaks, replace it with a new master link (90542517).

Main Parts List

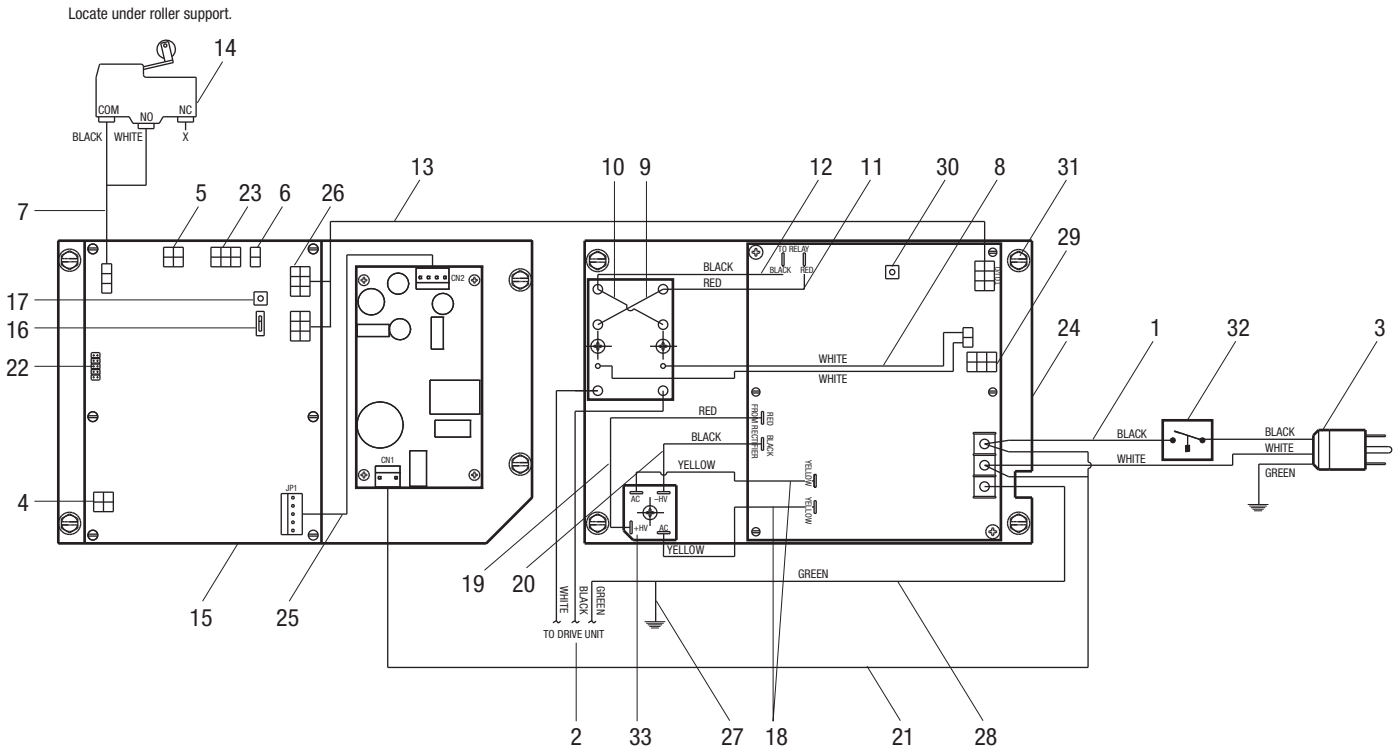
Key	UPC No. 78-3310-	Part No.	Description	Qty
2	01622	50016229	Frame weldment	1
3	38217	50382179	Guard weldment, top chain	1
4	38983	50389831	Guard assembly, front chain	1
4A	38236	50382365	Guard, front	1
4B	38244	50382446	Retainer	1
4C	50160	90501608	Rivet, 3/16" pop	2
5	38232	50382322	Guard weldment, motor	1
6	01607	50016075	Guard, bottom	1
7	38199	50381997	Sppt wldt, 1/2" to 1-1/4" RLR	1
8	38250	50382500	Drive unit	1
9	01702	50017020	Spindle weldment, main	1
10	38193	50381938	Plate weldment, drive	1
11	54253	90542533	Sprocket, #60 14T	1
12	38267	50382675	Key, drive sprocket	1
13	54255	90542550	Bearing, sleeve #48DU40	2
14	54250	90542509	Chain, #60 92P	1
15	54462	90544625	Ring, rtng Truarc #5100-200	4
16	38265	50382659	Washer, main spindle	2
17	38268	50382683	Key, shoe drive	1
18	38457	50384570	Plate, hoist	2
19	55204	90552040	Pin, 1/2" to 1-1/4" sprt pvt	1
20	38257	50382578	Spacer, motor mount	1
20A	39488	50394886	Spacer, thin motor mount	1
21	38228	50382284	Locator weldment, eccentric	1
22	54265	90542568	Nut, 1/2-13 lock	1
23	51655	90516559	Screw, #10-16 x .50 hex head	31
25	53903	90539036	Screw, cap 1/2-13 x 1.00	4
26	52501	90525019	Ring, rtng Truarc #5100-287	2
27	54345	90543459	Screw, set 1/2"-20 x .75 socket	1
28	54251	90542517	Link, connecting #60 chain	1
29	54240	90542409	Screw, #6-32 x 1.00 sltd mach	4
30	38246	50382462	Bracket, limit switch	1
31	38248	50382489	Back-plate, switch	3
32	50226	90502264	Screw, 5/16-18 x 1.25 skt. cap	2
33	52597	90525973	Washer, flat .56 x 1.37 x .109	4
34	85822	91858224	Switch, limit #BZ-2RW822-A2	4
35	50645	90506456	Nut, hex 5/16-18 reg jam	2
36	01708	50017080	Receptacle unit, pendant	1
37	54124	90541243	Strain relief	1
43	38780	50387804	Shoe unit, 1/2" to 1-1/4"	1
44	38148	50381482	Shoe unit, 1-1/2" to 2"	1
45	52203	90522036	Screw, mach #6-32 x .25	2
46	29708	50297082	Guard, breaker switch	1
47	86385	91863856	Breaker, circuit 20 amp	1
48	54619	90546199	Screw, cap #4-40 x .62 skt	2
49	38646	50386468	Encoder unit, optical	1
50	50572	90505727	Screw, cap #8-32 x .50 skt	4
51	86646	91866464	Brake, motor	1
52	38807	50388070	Key, brake	1
53	54616	90546164	Spacer, round plastic	2
54	54151	90541510	Knob, plastic w/set screw	2
55	54335	90543351	Screw, flng 1/4 x .37 thd	2
57	01648	50016482	Switch, pendant	1
57A	01305	50013050	Board, circuit	1
57B	33476	50334760	Cover	1
57C	33472	50334727	Housing, lower	1
57D	38649	50386492	Switch, membrane	1
57E	34342	50343424	Screw #4-20	3
57F	33580	50335804	Screw #6-32	3
57G	01666	50016660	Cord, pendant	1
58	35012 06683	50350129 50066838	Screw, #4 x 1/2" flat head **or** rivet, pop 3/32	2
59	51751	90517512	Screw, drive	4
60	38868	50388681	Nameplate	1
71	38221	50382217	Support weldment, roller	1
72	00528	50005286	Support weldment, 1-1/2"	1
73	00601	50006010	Support weldment, 2"	1
74	38225	50382250	Arm weldment, adjustment	1
75	00543	50005430	Plate, 1-1/2" outer roller	1
76	00604	50006045	Plate, 2" outer roller	1
77	38254	50382543	Rol, 1-1/2	2
78	38264	50382640	Ball, 1-1/2	2
79	38255	50382551	Rol, 2	2
80	38263	50382632	Ball, 2	2
81	38262	50382624	Spacer, 2 roller	1
82	00599	50005995	Roller unit, 2"	1
83	00493	50004930	Shaft, 2" rear roller	1
84	38252	50382527	Roller, 1-1/2 I.M.C.	1
85	38253	50382535	Roller, 2 tail	1
86	38260	50382608	Shaft, 1-1/2 pivot roller	1
87	32027	50320270	Sleeve, 1-1/2	1
88	31728	50317288	Shaft, 2 pivot	1
89	38151	50381512	Sleeve, 2	1
90	23258	50232584	Grip	1
91	38256	50382560	Shaft, eccentric	1
92	38251	50382519	Sleeve, adaptor	1
93	50540	90505409	Screw, 7/16-14 x 1.00 hex hd	3
94	00860	50008609	Shaft, 1-1/2" support	1
95	54819	90548191	Ring, retaining #5100-87	2
96	54242	90542428	Screw, cap 1/4-20 x .37 btn hd	3
97	50224	90502248	Screw, 5/16-18 x 1.00 skt hd	1
98	50881	90508815	Screw, 1/4-28 x .25 set	2
99	53018	90539184	Washer, 1.00 x 1.37 x .03 shim	1
100	54248	90542487	Washer, Belleville 1.362 x .803	2
101	39440	50394401	Washer, .62 x 2.00 x .06 flat	1
104	54243	90542436	Spring, extension .75 x 3.50	2

Main Parts List (cont'd)

Key	UPC No. 78-3310-	Part No.	Description	Qty
105	54252	90542525	Clamp, loop-type	1
106	52108	90521080	Nut, hex 1/4-20	1
107	54239	90542398	Screw, 1/4-20 x 3/4 ovl pt set	1
108	39851	50398512	Cam, retention	1
109	38463	50384635	Shaft, cam retention	1
111	38544	50385445	Plate, cam retention	1
112	38566	50385666	Spring, cam retention	1
113	54268	90542681	Screw, 1/4-20 x 1-3/8 skt cap	1
114	50458	90504585	Rollpin, 1/8 x .375	1
115	38592	50385925	Guide, spring	1
116	51130	90511301	O-ring, 1.50 x 1.62 x .062	2
117	51537	90515374	O-ring, 1.75 x 1.87 x .062	2
118	38657	50386573	Shaft, 2 middle roller	1
119	52644	90526449	Washer, 1/32 shim	1
150	52645	90526457	Washer, 1/16 shim	1
151	53216	90532163	Ring, retaining	1
170	86263	91862639	Nut, 1/2" conduit lock	1
176	54911	90549112	Screw, 1/4-28 x 3/8" socket head cap	2
177	55302	90553020	Screw, #6-32 x 1.25 socket head	2
178	54355	90543556	Washer, #6	6
179	07912	50079123	Power cord	1
201		52031175	Base assembly	1
202		52031167	Tower assembly, trunnion, L.H.	1
203		52031170	Tower assembly, trunnion, R.H.	1
204	53390	90533909	Wheel	2
205	38613	50386131	Axle, short	2
206	51528	90515285	Ring, retaining #5160-75	4
207	54237	90542371	Screw, flange 3/8-16 x 1.00 hex	8
208	52646	90526465	Nut, 3/8-16 Esna hex	4
209	38167	50381679	Pin, trunnion lock	1
211	54244	90542444	Spring, trunnion lock	1
212	38168	50381687	Knob	1
213		52031172	Caster, w/side lock	2
221	31710	50317105	1/2" to 1-1/4" IMC, Rigid hook	1
223	31712	50317121	1/2" to 1-1/4" EMT hook	1
224	52479	90524799	Drive bolt, 1/2-13 x .62 socket head cap screw	6
225	51088	90510887	1/2" to 1-1/4" Hook bolts, 3/8-16 x 1-1/4 socket head cap screw	8
226	53396	90533968	1-1/2, 2" Hook shoulder bolts, 3/4 x 1-1/2	6
228	31716	50317164	1-1/2, 2" EMT hook	1
229	38779	50387790	1-1/2, 2" IMC & Rigid hook	1
231	10299	50102990	Selector switch unit w/o knobs	1
240		52031173	Flange, screw	4

Key	UPC No. 78-3310-	Part No.	Description	Qty
Decals (not shown)				
	38893	50078852	Decal, lifting eye	2
	01445	50014455	Decal, deluxe pendant instr.	1
	38896	50388967	Decal, Slct switch size	1
	01487	50014870	Decal, Slct switch type	1
	38898	50388983	Decal, bender pivot lock	1
	38899	50388991	Decal, roller adjustment	1
	02263	50022636	Decal, roller engagement	1
	01568	50015680	Decal, operation	3
	38974	50389742	Decal, circuit breaker	1
	01453	50014536	Decal, shoe orientation	2
		52025721	Decal, warning	1
		52031174	Decal, warning	2
Optional				
	01711	50017110	Deluxe pendant control	
	38962	50389629	Vinyl cover (not shown)	
	01700	50017004	1/2" to 2" PVC shoe group	
Service Only				
233	05586	50055860	Frame unit (includes bearings)	1
☐		50079395	Cam repair kit	1
57H		52020832	Stripping, magnetic - replacement	1
		52033403	Service kit (includes base and LH & RH trunnions)	1

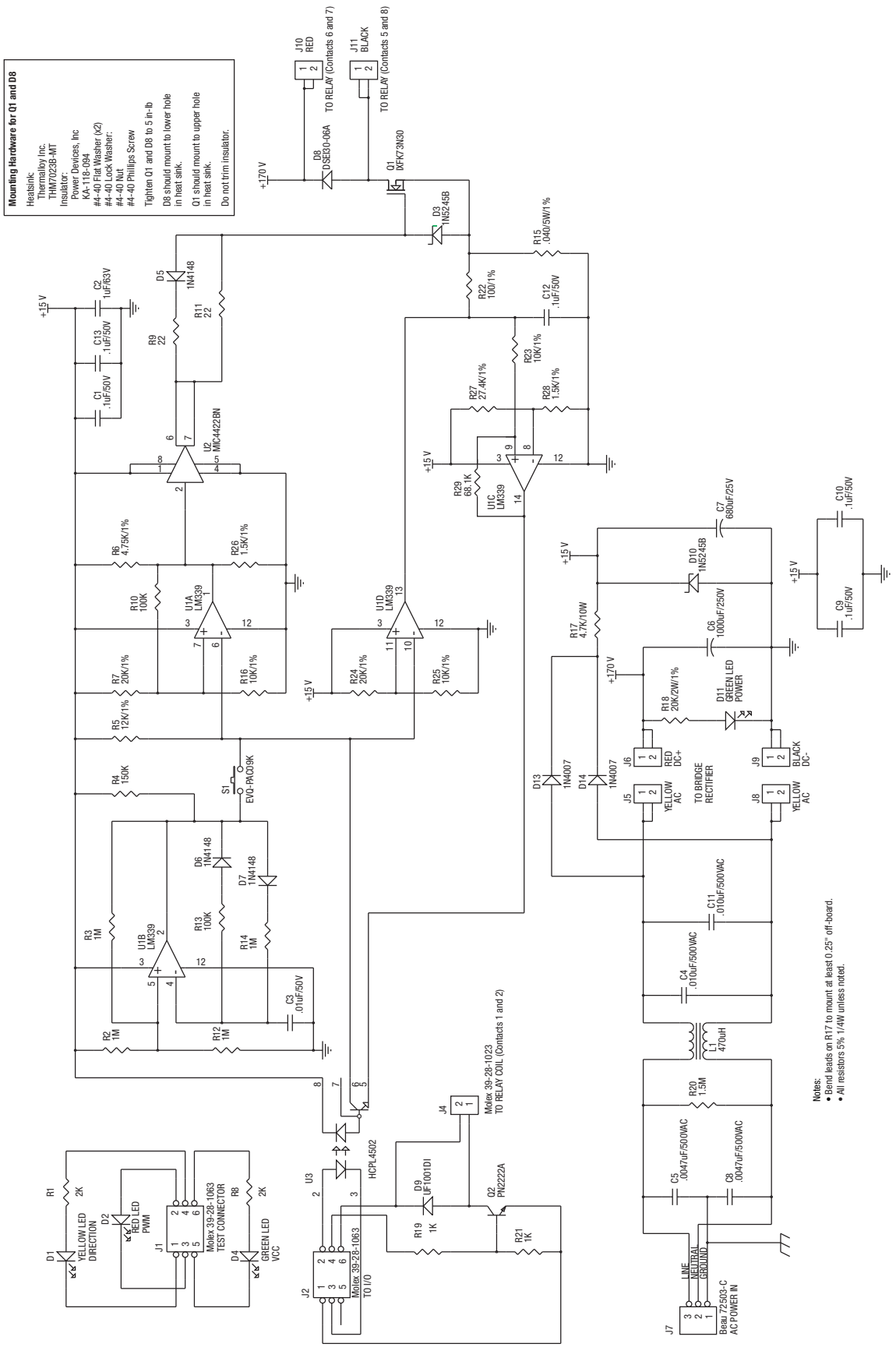
Electrical Control System Layout and Parts List



Key	Part No.	Description
1	50389416	PGU Power Wire
2	50382500	Motor
3	50079123	Power Cord
4	50017080	Receptacle Unit
5	50386360	Limit Switch Wire Unit
6	50386379	Brake Wire Unit
7	50102354	Unload Lockout Switch Wire Unit
8	50060473	Relay Wire Unit
9	50060481	Red Relay Wire
10	50060490	Black Relay Wire
11	50060341	Red Relay–PGU Wire
12	50060350	Black Relay–PGU Wire
13	50386484	I/O–PGU Wire Unit
14	91858224	Limit Switch
15	50060309	Input/Output Control Unit
16		Directional Test Toggle Switch

Key	Part No.	Description
17		Test Pushbutton Switch
18	50060503	Yellow Rectifier Wires
19	50060384	Red Rectifier Wire
20	50060422	Black Rectifier Wire
21	50060368	Wire Unit, Power AC
22	50081519	Selector Switch Unit w/o knobs
23	50386468	Optical Encoder
24	50054678	Power Generation Board Assembly
25	50060376	Wire Unit, Power DC
26		Test Terminal (Troubleshooting)
27	90543297	Screw, #8-18 x 3/8 Ground
28	50060406	Wire Unit, Ground
29		Test Terminal (Troubleshooting)
30		Test Pushbutton (Troubleshooting)
31	90516559	Screw, #10-16 x .5 Hex
32	91863856	Circuit Breaker, 20 A
33	91859972	Rectifier, 600 V, 35 A

Power Generation Unit (50054678) Schematic Diagram



Power Generation Unit (50054678) Parts List

Reference	Supplier	Part Number	Description	Qty
C1,C9,C10,C12,C13	Philips AVX KEMET	A104K29X7RFVVWN SA115C104KAA C420C104K5R5CA	Capacitor, 0.1 uF, 50 volts	5
C2	WIMA	MKS21.06310	Capacitor, film, 1 uF, 63 volts	1
C3	Philips AVX	A103M15Z5UFVVWA SA105E103ZAA	Capacitor, .01 uF, 50 volts	1
C4,C11	Sprague	440LS10	Capacitor, .010 uF, 500 volts AC	2
C5,C8	Sprague	440LD47	Capacitor, .0047 uF, 500 volts AC	2
C6	Panasonic Cornell Dubilier	ECE-S2EU102Z 380LX102M250K052	Capacitor, 1000 uF, 250 volts	1
C7	Panasonic	EEU-FC1E681	Capacitor, 680 uF, 25 volts	1
D1	Panasonic Liteon	LN48YP LTL-4251	LED, T1, amber	1
D2	Panasonic Liteon	LN28RP LTL-4221	LED, T1, red	1
D3,D10	Motorola	1N5245B	Zener diode, 15 volts, 500 milliwatts	2
D4,D11	Panasonic Liteon	LN38GP LTL-4231	LED, T1, green	2
D5,D6,D7	Generic	1N4148	Diode	3
D8	IXYS Adv Pwr Tech Adv Pwr Tech	DSEI 30-06A APT30D40B APT30D60B	Diode, fast recovery, 30A, 400-600V, TO-247 (see Note 1)	1
D9	Vishay	UF1001DI	Diode, ultra-fast switching, 1A, 50V, 50ns, DO-41	1
D13,D14	Generic	1N4007	Diode	2
J1,J2	Molex	39-29-0063	Connector, Minifit Jr., 6-position, gold	2
J4	Molex	39-29-0023	Connector, Minifit Jr., 2-position, gold	1
J5,J6,J8,J9,J10,J11	Keystone	1287	Connector, tab, .250 x .032	6
J7	Beau Magnum	72503-C A202203	Connector, terminal block, 3-position, no mount holes	1
L1	Renco	RL-1328-22-470	Choke, common mode	1
Q1	IXYS Adv Pwr Tech	IXFK73N30 APT30M40LVFR	MOSFET, N channel, 73-76A, 300V, TO-264 (see Note 2)	1
Q2	Generic	PN2222A	Transistor, NPN	1
R1,R8	Generic		Resistor, 2 kΩ, 1/4 watt, 5%	2
R2,R3,R12,R14	Generic		Resistor, 1 MΩ, 1/4 watt, 5%	4
R4	Generic		Resistor, 150 kΩ, 1/4 watt, 5%	1
R5	Generic		Resistor, 12.1 kΩ, 1/4 watt, 1%	1
R6	Generic		Resistor, 4.75 kΩ, 1/4 watt, 1%	1
R7,R24	Generic		Resistor, 20 kΩ, 1/4 watt, 1%	2
R9,R11	Generic		Resistor, 22 Ω, 1/4 watt, 5%	2
R10,R13	Generic		Resistor, 100 kΩ, 1/4 watt, 5%	2
R15	Dale KRL Riedon	LVR-5 .04W NP-5A .04W MT-5 .04W	Resistor, .040 Ω, 5 watt, 1%	1
R16,R23,R25	Generic		Resistor, 10 kΩ, 1/4 watt, 1%	3
R17	Dale KRL Riedon	CW-10 4.7K C-10A 4.7K UT-10 4.7K	Resistor, 4.7 kΩ, 10 watt, 5% (see Note 3)	1
R18	Dale KRL	RS-2B-20K C-2A 20K	Resistor, 20 kΩ, 2 watt, 1%	1

Power Generation Unit (50054678) Parts List (cont'd)

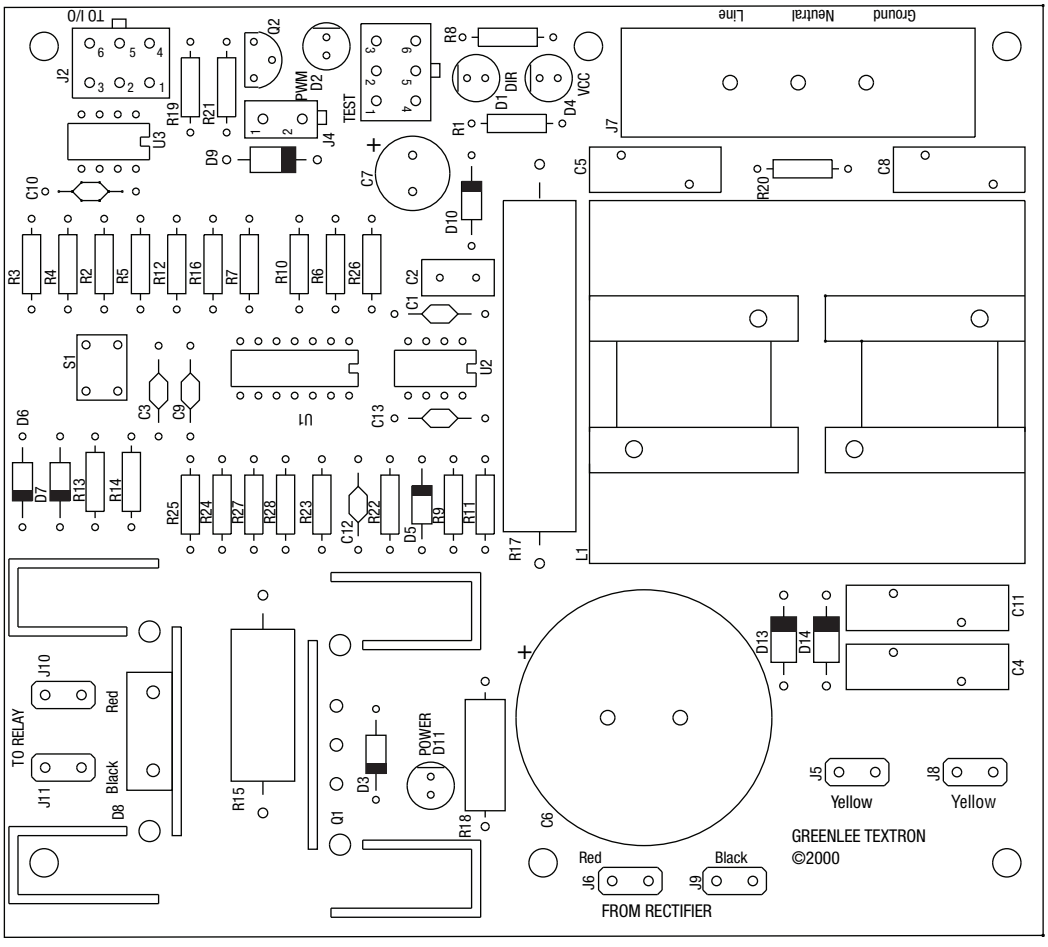
Reference	Supplier	Part Number	Description	Qty.
	Riedon	UT-2B 20K		
R19,R21	Generic		Resistor, 1 kΩ, 1/4 watt, 5%	2
R20	Generic		Resistor, 1.5 MΩ, 1/4 watt, 5%	1
R22	Generic		Resistor, 100 Ω, 1/4 watt, 1%	1
R26,R28	Generic		Resistor, 1.5 kΩ, 1/4 watt, 1%	2
R27	Generic		Resistor, 27.4 kΩ, 1/4 watt, 1%	1
R29	Generic		Resistor, 68.1 kΩ, 1/4 watt, 1%	1
S1	Panasonic	EVQ-PAC09K	Switch, momentary pushbutton	1
U1	Motorola	LM339AN	IC, low power quad comparitor	1
U2	Micrel	MIC4422BN	IC, 9-A peak low-side non-inverting MOSFET driver	1
U3	HP QT-Opto Siemens	HCPL4502 HCPL4502 6N136	IC, opto-isolator	1

Note 1: Mount D8 to bottom hole of heat sink.

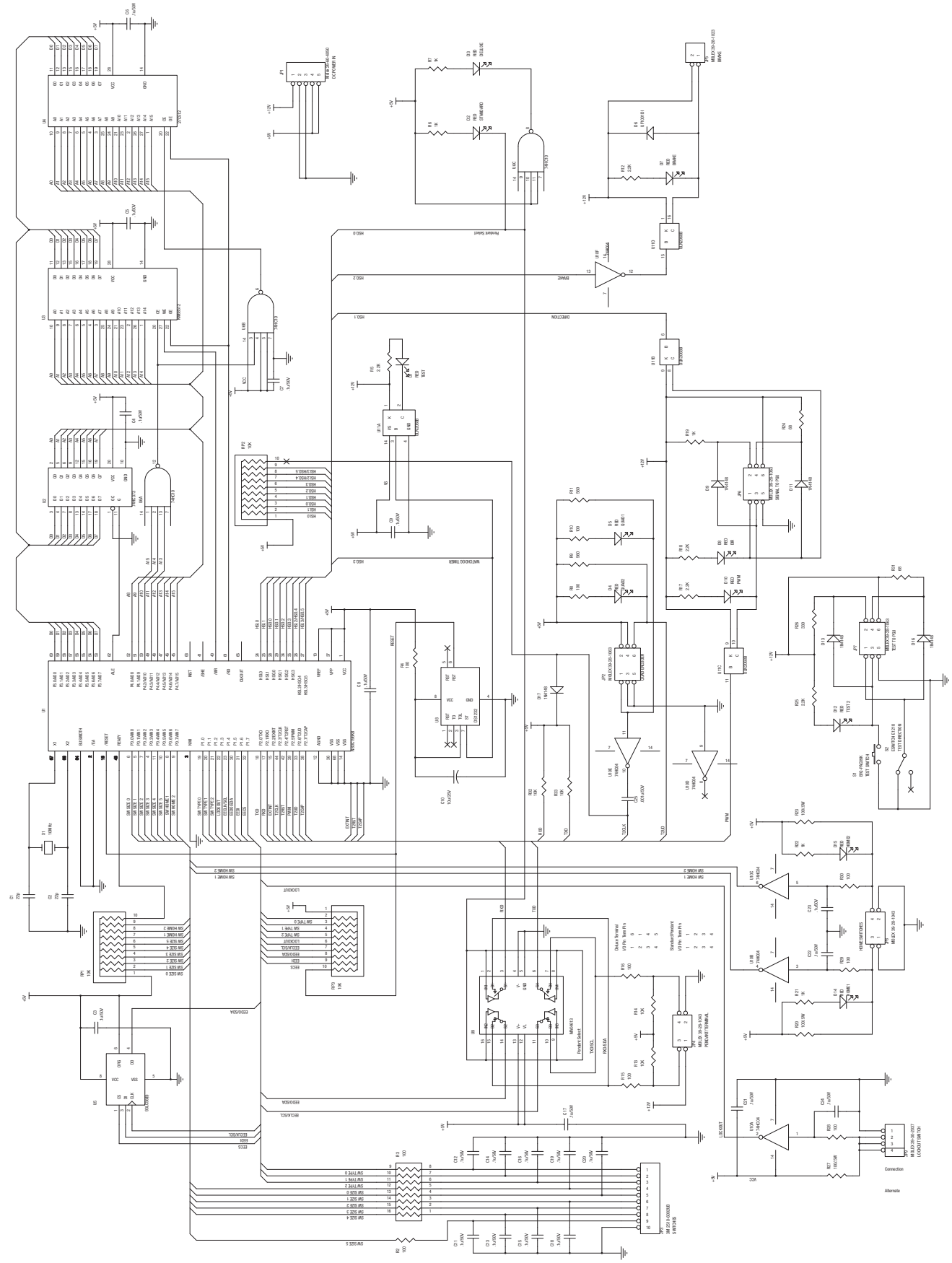
Note 2: Mount Q1 to top hole of heat sink.

Note 3: Bend leads and mount 0.25" off-board.

Power Generation Unit (50054678) Layout Diagram



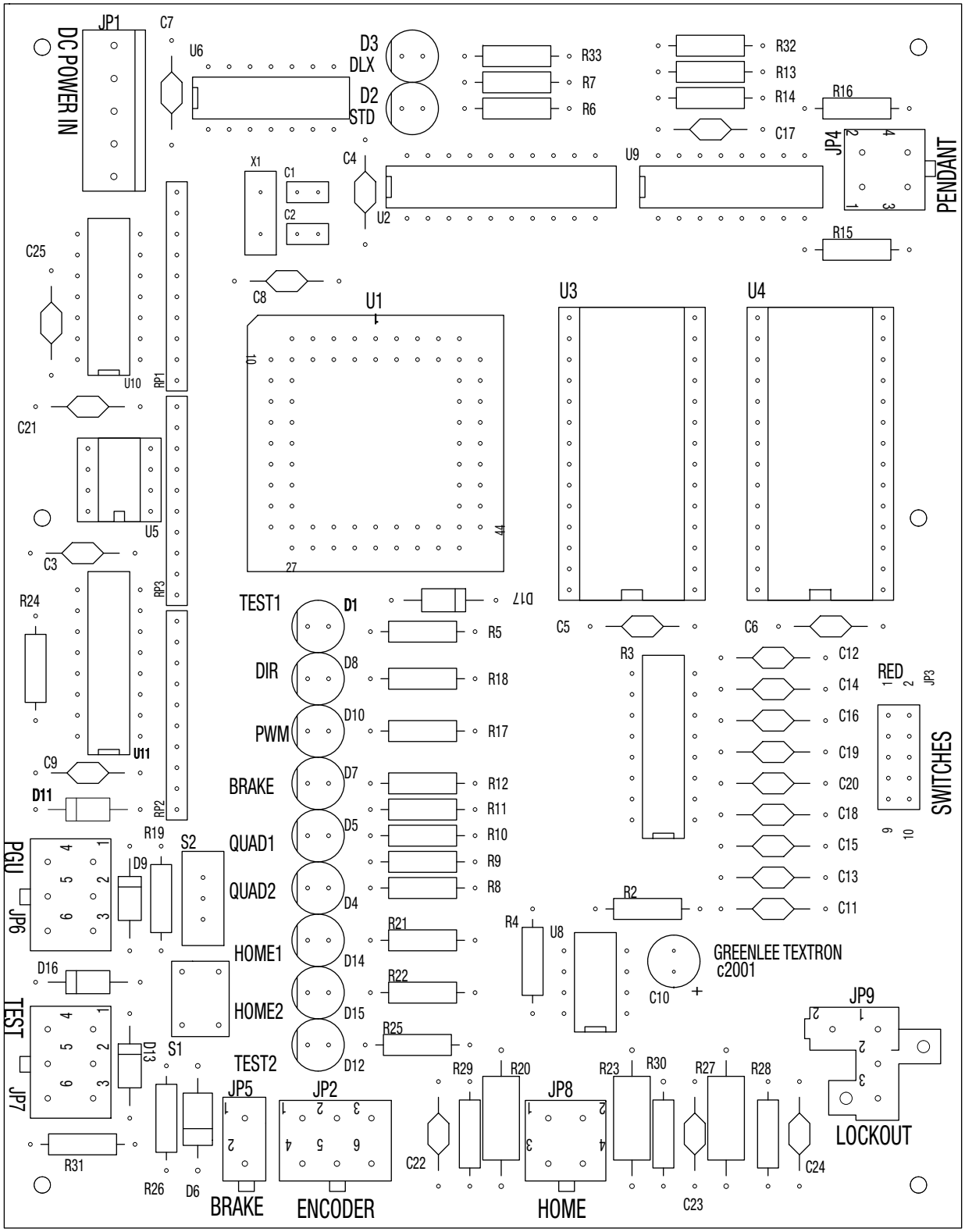
Input/Output Board (50060309) Schematic Diagram



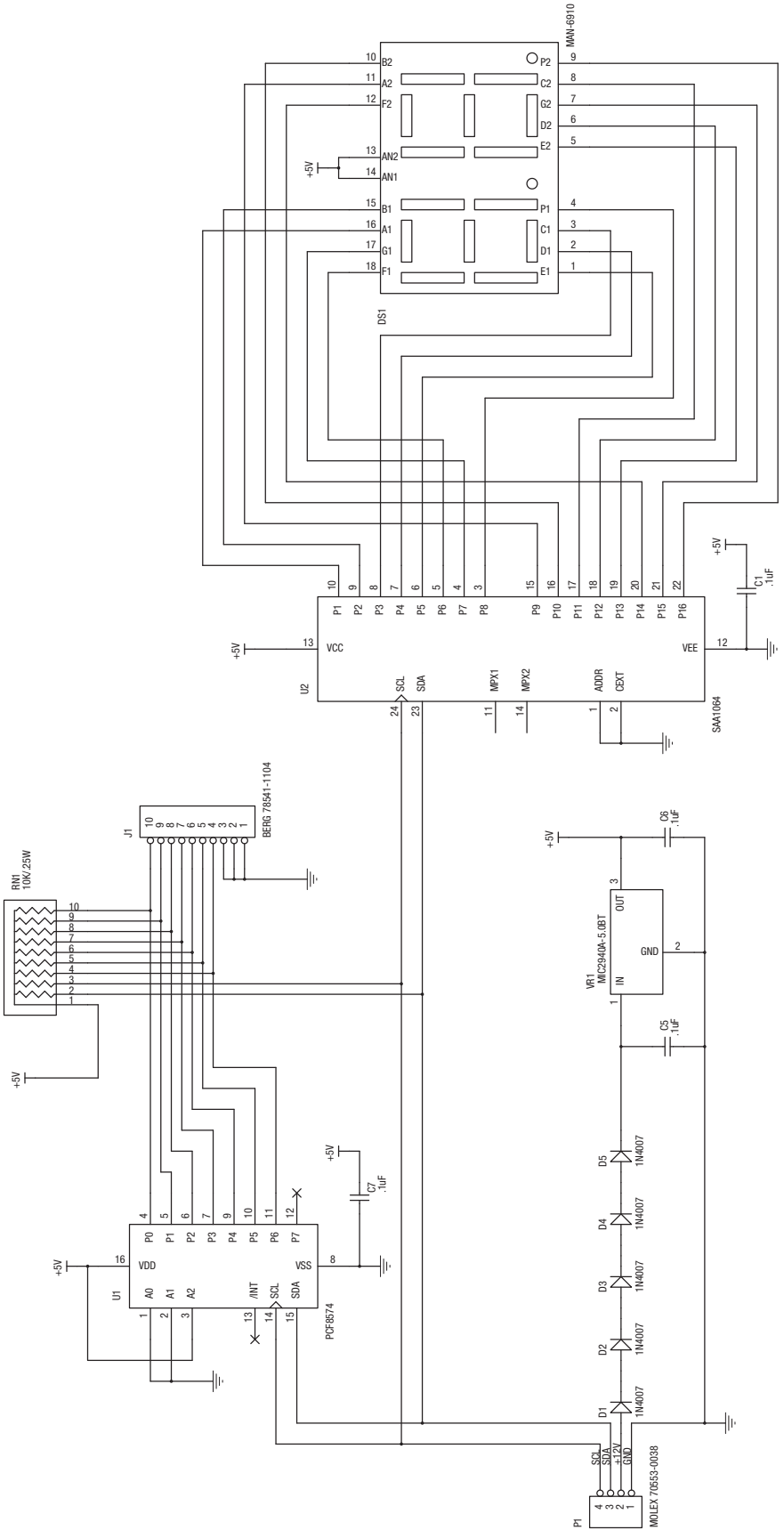
Input/Output Board (50060309) Parts List

Reference	Supplier	Part Number	Description	Qty.
C1,C2	Murata Murata	RPE110COG220J050V RPE110COG220J0100V	Capacitor, 22 pF, 50 volts	2
C3,C4,C5,C6,C7,C8,C9, C11,C12,C13,C14,C15, C16,C17,C18,C19,C20, C21,C22,C23,C24	Philips AVX KEMET	A104K29X7RFVVWN SA115C104KAA C420C104K5R5CA	Capacitor, 0.1 uF, 50 volts	21
C10	Nichicon	UVZ1E100MDH	Capacitor, 10 uF, 25 volts	1
C25	Philips	A102K15X7RHVVWA	Capacitor, .001 uF, 100 volts	1
D1,D2,D3,D4,D5,D7,D8, D10,D12,D14,D15	Panasonic Liteon	LN28RP LTL-4221	LED, T1, red	11
D9,D11,D13,D16,D17	Generic	1N4148	Diode	5
D6	VISHAY	UF1001DI	Diode, ultra-fast switching, 1A, 50V, 50ns, DO-41	1
JP1	Molex	26-60-4050	Connector, locking, .156" center, 5-position	1
JP4,JP8	Molex	39-28-1043	Connector, Minifit Jr., 4-position	2
JP2,JP6,JP7	Molex	39-28-1063	Connector, Minifit Jr., 6-position	3
JP3	3M	2510-6002UB	Connector, dual row, 10-position	1
JP5	Molex	39-28-1023	Connector, Minifit Jr., 2-position	1
JP9	Molex	39-30-2037	Connector, Minifit Jr., 3-position	1
RP1,RP2,RP3	Bourns	4610X-101-103	Resistor pack, 10KWx8 with common, 1/4 watt, 5%	3
R13,R14,R32,R33	Generic		Resistor, 10K, 1/4 watt, 5%	4
R6,R7,R19,R21,R22	Generic		Resistor, 1K, 1/4 watt, 5%	5
R3	Dale	MDP1603-101G	Resistor pack, 100Wx8, individual, 1/4 watt, 5%	1
R2,R4,R8,R10,R15,R16, R28,R29,R30	Generic		Resistor, 100, 1/4 watt, 5%	9
R5,R12,R17,R18,R25	Generic		Resistor, 2.2K, 1/4 watt, 5%	5
R11,R9	Generic		Resistor, 560, 1/4 watt, 5%	2
R26	Generic		Resistor, 330, 1/4 watt, 5%	1
R20,R23,R27	Generic		Resistor, 100, 1/2 watt, 5%	3
R31,R24	Generic		Resistor, 68, 1/4 watt, 5%	2
S1	Panasonic	EVQ-PAC09K	Momentary pushbutton switch	1
S2	Eswitch	EG1218	Slide switch, SPDT	1
U1	Intel	N80C196KB	Integrated circuit, microcontroller	1
U1	AMP	821689-1	68-pin socket, PLCC	1
U2	Generic	74HC373	Integrated circuit, buffer	1
U3	Samsung	KM62256DLP-7L	IC, SRAM, 32K x 8, 70ns, 28-pin x .6" DIP	1
U4	Generic	27C256	IC, EPROM, 120 nsec, 28-pin x .6" DIP	1
U3,U4	Robinson Nugent	ICO-286-S8A-T	28-pin socket, dual wipe	2
U5	Microchip Microchip	93LC56 93LC56B	Integrated circuit, EEPROM,128 x 16 bit	1
U5	Robinson Nugent	ICO-083-S8A-T	8-pin socket, dual wipe	1
U6	Generic	74HC10	Integrated circuit, NAND	1
U8	Dallas Dallas	DS1232 DS1232LP	Integrated circuit, timer/reset control	1
U9	Maxim	MAX4613	IC, analog switch, 16 pin x .3" DIP	1
U10	Generic	74HC04	Integrated circuit, inverter	1
U11	Generic	ULN2068B	Integrated circuit, buffer/driver	1
X1	Fox	FOX 100-20, HC49U-10.000-MS	Crystal, 10MHz, HC49U case, mylar spacer	1

Input/Output Board (50060309) Layout Diagram



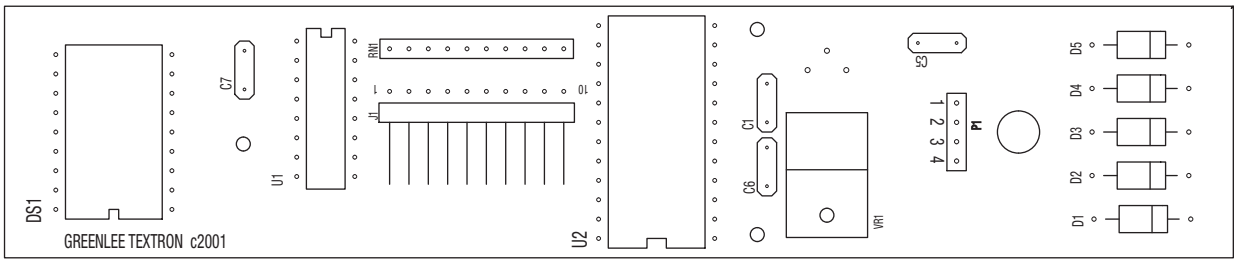
Standard Pendant Switch (50013050) Schematic Diagram



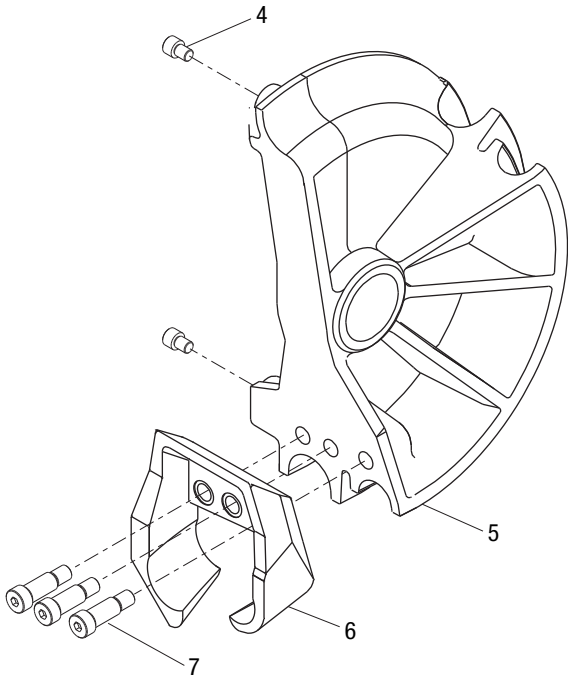
Standard Pendant Switch (50013050) Parts List

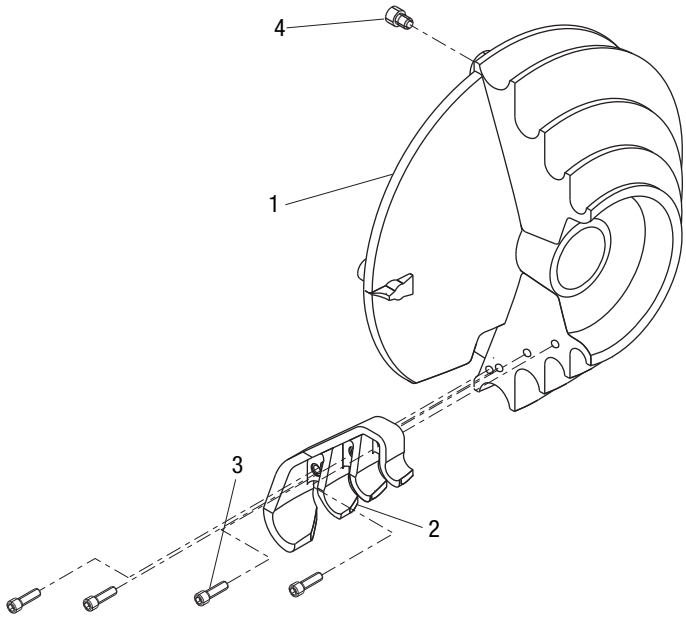
Reference	Supplier	Part Number	Description	Qty.
C1,C5,C6,C7	Vishay or Equal	1C20X7R104K050B or Equal	Capacitor, ceramic, .1 uF, 50 volts (minimum), radial, .2 cc, X7R	4
D1,D2,D3,D4,D5,D6	Generic	1N400x (x=1 to 7)	Diode	5
DS1	QT Opto Agilent Tech or Equal	MAN-6910 HDSP-5521 or Equal	LED display, common anode, 2 digit x .56, 7 seg + dec, 18-lead .6" DIL	1
J1	BERG or Equal	78541-110H or Equal	Connector, .100" cc x .318 mating, 10-position, right angle, single row, 30 micro-in gold over 50 micro-in nickel	1
P1	MOLEX	70553-0038	Connector, locking, “SL” series, .100" cc, 4-position	1
RN1	Generic		Resistor pack, 10KWx10 with common, 1/4 watt, 5%	1
U1	Philips	PCF8574P	Integrated circuit, I2C, 8-bit I/O expander, 16-lead .3" DIL	1
U2	Philips	SAA1064	Integrated circuit, I2C, LED display driver, 24-lead .6" DIL	1
VR1	Micrel	MIC2940A-5.0BT	Voltage regulator, fixed 5V, low dropout	1
Mounting Hardware for VR1				
	Generic	#4-40 Hex Nut	ZN steel or stainless, nylon insert, 1/4 x 9/64	1
	Generic	#4-40 Phillips Screw	ZN steel or stainless, machine, pan head, #4-40 x 0.25"	1

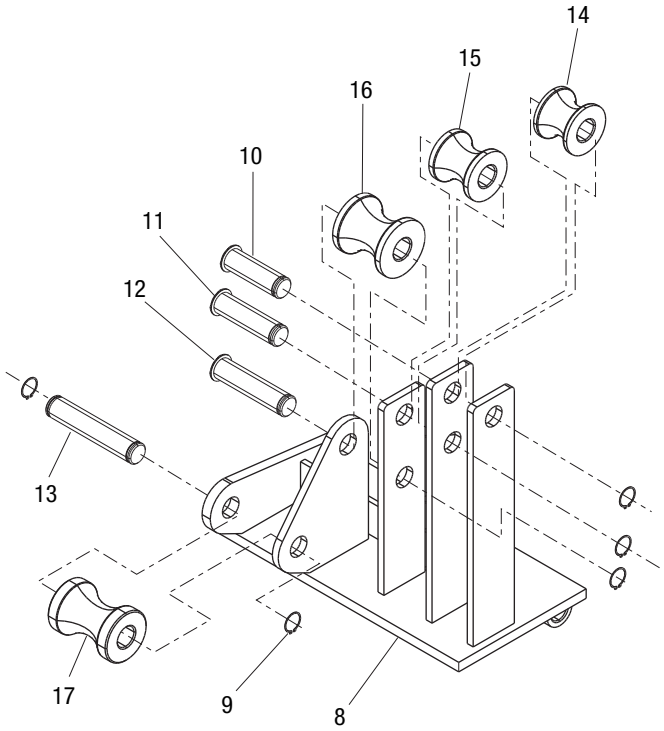
Standard Pendant Switch (50013050) Layout Diagram



Optional Bending Attachments for 1/2" to 2" 40 Mil PVC-coated Rigid (50017004) Exploded View and Parts List







Key	UPC No. 78-3310-	Part No.	Description	Qty
	00572	50005723	Shoe unit, 1/2" to 1-1/4" PVC-coated Rigid (includes items 1–4)	1
	31919	50319191	Shoe unit, 1-1/2" to 2" PVC-coated Rigid (includes items 4–7)	1
	00934	50009346	Support unit, 1/2" to 1-1/4" PVC-coated Rigid (includes items 8–17)	1
1	00567	50005677	1/2" to 1-1/4" PVC-coated Rigid shoe	1
2	00570	50005707	1/2" to 1-1/4" PVC-coated Rigid hook	1
3	51088	90510887	3/8-16 x 1-1/4" Socket head cap screw	4
4	52479	90524799	1/2-13 x 5/8" Socket head cap screw	5
5	31918	50319183	1-1/2" to 2" PVC-coated Rigid shoe	1
6	31916	50319167	1-1/2" to 2" PVC-coated Rigid hook	1
7	53396	90533968	3/4" x 1-1/2" Shoulder screw	3
8	00933	50009338	Support weldment, PVC-coated Rigid roller	1
9	51353	90513533	Retaining ring	5
10	00923	50009230	1/2" Roller axle	1
11	00924	50009249	3/4" Roller axle	1
12	00925	50009257	1" Roller axle	1
13	00926	50009265	1-1/4" Roller axle	1
14	00927	50009273	1/2" Roller	1
15	00928	50009281	3/4" Roller	1
16	00929	50009290	1" Roller	1
17	00930	50009303	1-1/4" Roller	1
18	54910	90549104	Retaining ring pliers (not shown)	1
19	23818	50238183	Metal storage box (not shown)	1

Troubleshooting

Problem	Probable Cause	Probable Remedy
Bender does not operate.	No voltage.	Check supply voltage circuit operation. Check that switch is on. Check that pendant is fully plugged in.
Bender operates, but display is blank.	Insufficient voltage.	Use shorter or larger gauge extension cord. Check supply voltage (80 VAC minimum).
	Pendant was plugged in while bender was on.	Turn bender switch off and on.
Display comes on, but bender does not bend.	Bender was advanced 93 degrees.	**UNLOAD** to desired position.
Display comes on, but does not count during bend.	Bender turned on while conduit was fully loaded.	Remove conduit and initialize home position per “Setting the Home Position” under “Operation” in the instruction manual.
Bender operates in wrong direction.	Wrong conduit size and/or type selected.	Set selector switches properly.
Bends are overbent a few degrees.	Wrong conduit size and/or type selected.	Set selector switches properly.
	Too much squeeze on 1-1/2" or 2" EMT, IMC, or rigid aluminum conduit.	Back squeeze off per adjustment instructions.
	Unusual conduit characteristics.	Refer to “Accuracy” in the “Adjustments” section or bend to a smaller angle to compensate.
Bends are underbent a few degrees.	Wrong conduit size and/or type selected.	Set selector switches properly.
	Too little squeeze on 1-1/2" or 2" EMT, IMC, or rigid aluminum conduit.	Increase squeeze per adjustment instructions.
	Unusual conduit characteristics.	Refer to “Accuracy” in the “Adjustments” section or bend to a larger angle to compensate.

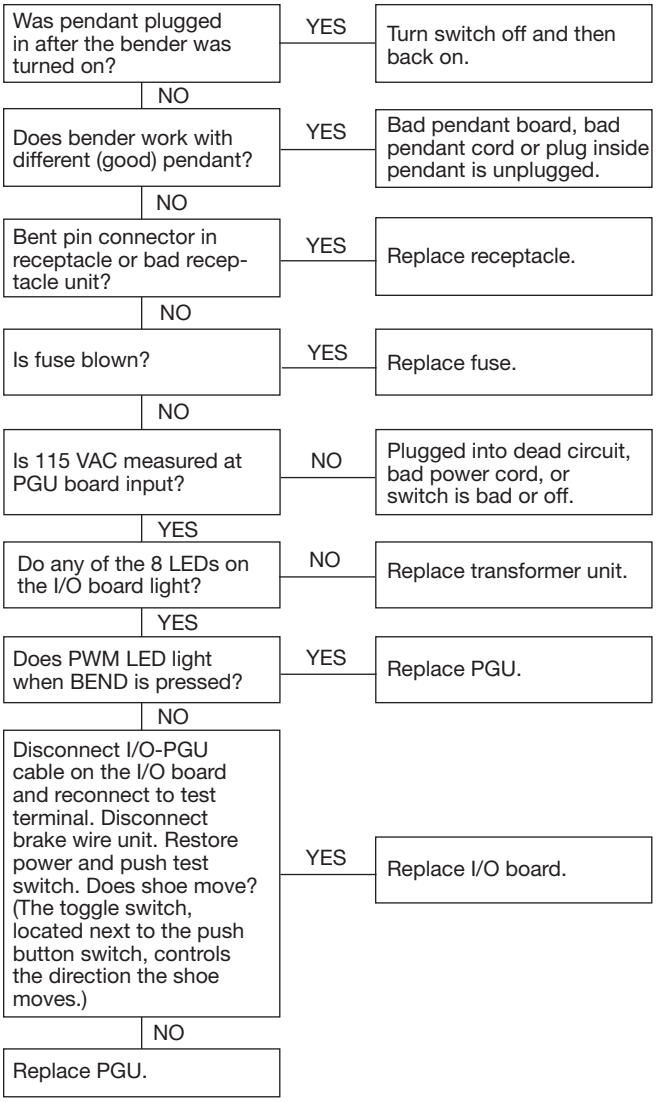
Troubleshooting (cont'd)

Problem	Probable Cause	Probable Remedy
UNLOAD key does not work.	Roller support is not all the way down.	Release the roller support.
	Unloaded to the starting position.	Release and press **UNLOAD** again.
Locking cam does not engage.	Too much squeeze on 1-1/2" or 2" EMT, IMC, or rigid aluminum conduit.	Back squeeze off per adjustment instructions.
	Shoe rotated too far in unload direction.	Rotate shoe with **BEND** key until locking cam engages.
Bend key does not work for 1/2" to 1-1/4" conduit.	Roller support is not all the way down.	Release the roller support.
Message "E6" or "CONDUIT SUPPORT UP" appears.	Power was turned off while bending 1-1/2" or 2" EMT, IMC, or rigid aluminum conduit.	Press **UNLOAD**. Bending shoe will slowly unload until roller support retracts.
	Roller support lockout switch or wire harness is bad or poorly adjusted.	Adjust switch. Check for pinched wires and shorts to frame.
	Roller support is locked or jammed.	Twist roller support handle counterclockwise.
Deluxe pendant displays: "BENDER CANNOT MAKE BENDS THAT CLOSE."	Due to the geometry of the bend, the shoe hook would end up interfering with the first bend while making the second.	Follow the suggestions on the display to adjust the HEIGHT, ANGLE, or STRAIGHT section value.
Deluxe pendant displays: "LENGTH IS TOO SHORT" or "HEIGHT IS TOO SHORT."	The first mark must be at least one pipe diameter away from the end of the conduit to prevent damage to the conduit.	Follow the suggestions on the display to adjust the LENGTH or HEIGHT value.

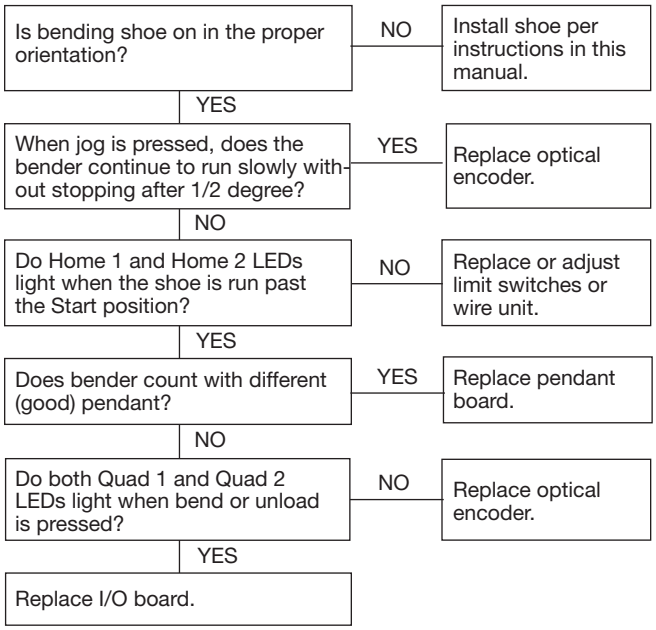
Troubleshooting (cont'd)

The following flow charts show some of the most likely areas to look at for certain problems. They by no means encompass all the possible problems or the only possible solutions.

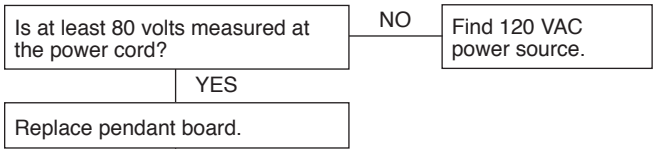
Won't bend – display blank


Was pendant plugged in after the bender was turned on?
YES
Turn switch off and then back on.
NO
Does bender work with different (good) pendant?
YES
Bad pendant board, bad pendant cord or plug inside pendant is unplugged.
NO
Bent pin connector in receptacle or bad receptacle unit?
YES
Replace receptacle.
NO
Is fuse blown?
YES
Replace fuse.
NO
Is 115 VAC measured at PGU board input?
NO
Plugged into dead circuit, bad power cord, or switch is bad or off.
YES
Do any of the 8 LEDs on the I/O board light?
NO
Replace transformer unit.
YES
Does PWM LED light when BEND is pressed?
YES
Replace PGU.
NO
Disconnect I/O-PGU cable on the I/O board and reconnect to test terminal. Disconnect brake wire unit. Restore power and push test switch. Does shoe move? (The toggle switch, located next to the push button switch, controls the direction the shoe moves.)
YES
Replace I/O board.
NO
Replace PGU.

Will bend – won't count

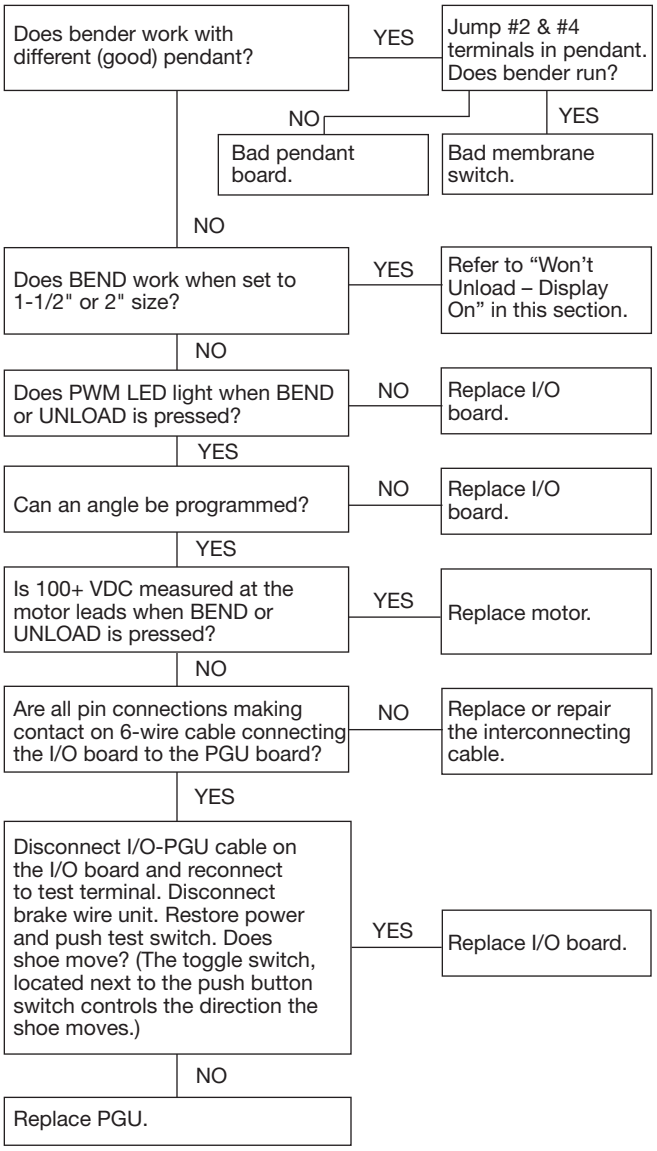

Is bending shoe on in the proper orientation?
NO
Install shoe per instructions in this manual.
YES
When jog is pressed, does the bender continue to run slowly without stopping after 1/2 degree?
YES
Replace optical encoder.
NO
Do Home 1 and Home 2 LEDs light when the shoe is run past the Start position?
NO
Replace or adjust limit switches or wire unit.
YES
Does bender count with different (good) pendant?
YES
Replace pendant board.
NO
Do both Quad 1 and Quad 2 LEDs light when bend or unload is pressed?
NO
Replace optical encoder.
YES
Replace I/O board.

Will bend – display blank

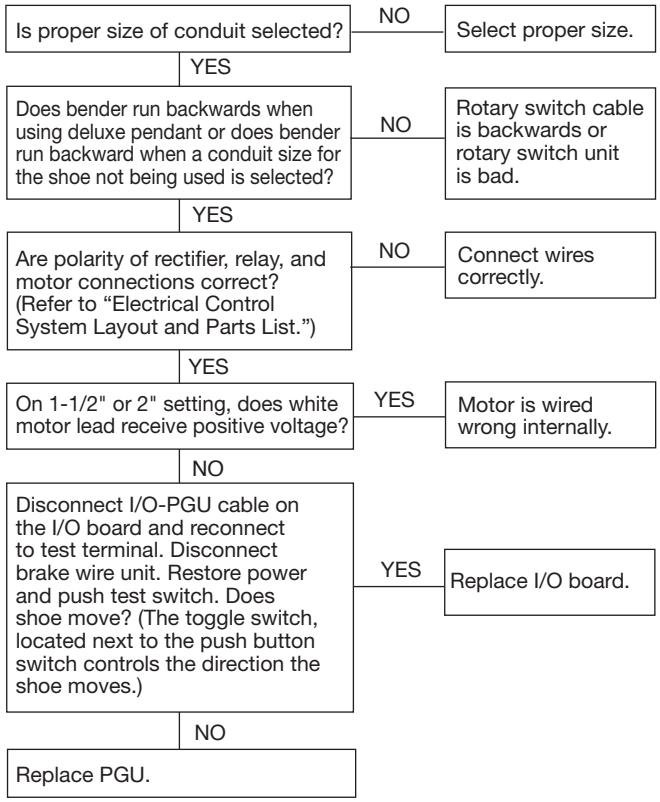


Troubleshooting (cont'd)

Won't bend – display on

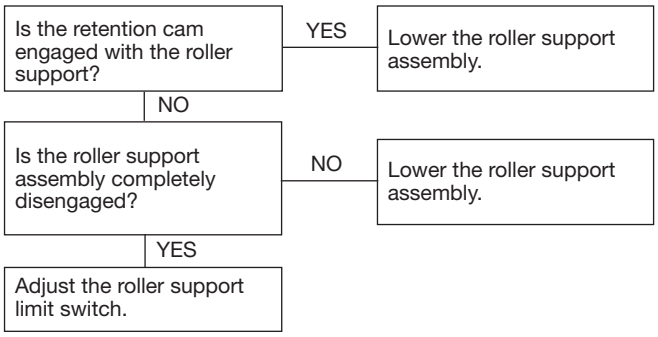

Does bender work with different (good) pendant?
YES
Jump #2 & #4 terminals in pendant. Does bender run?
NO
YES
Bad pendant board.
Bad membrane switch.
NO
Does BEND work when set to 1-1/2" or 2" size?
YES
Refer to "Won't Unload – Display On" in this section.
NO
Does PWM LED light when BEND or UNLOAD is pressed?
NO
Replace I/O board.
YES
Can an angle be programmed?
NO
Replace I/O board.
YES
Is 100+ VDC measured at the motor leads when BEND or UNLOAD is pressed?
YES
Replace motor.
NO
Are all pin connections making contact on 6-wire cable connecting the I/O board to the PGU board?
NO
Replace or repair the interconnecting cable.
YES
Disconnect I/O-PGU cable on the I/O board and reconnect to test terminal. Disconnect brake wire unit. Restore power and push test switch. Does shoe move? (The toggle switch, located next to the push button switch controls the direction the shoe moves.)
YES
Replace I/O board.
NO
Replace PGU.

Bender runs backwards for bend and unload

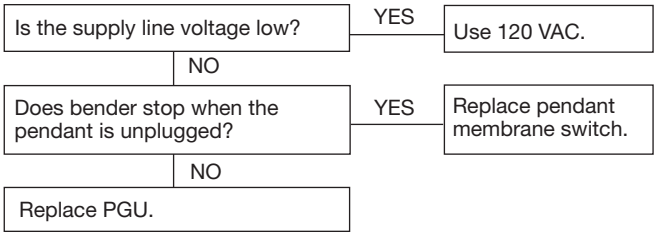

Is proper size of conduit selected?
NO
Select proper size.
YES
Does bender run backwards when using deluxe pendant or does bender run backward when a conduit size for the shoe not being used is selected?
NO
Rotary switch cable is backwards or rotary switch unit is bad.
YES
Are polarity of rectifier, relay, and motor connections correct? (Refer to "Electrical Control System Layout and Parts List.")
NO
Connect wires correctly.
YES
On 1-1/2" or 2" setting, does white motor lead receive positive voltage?
YES
Motor is wired wrong internally.
NO
Disconnect I/O-PGU cable on the I/O board and reconnect to test terminal. Disconnect brake wire unit. Restore power and push test switch. Does shoe move? (The toggle switch, located next to the push button switch controls the direction the shoe moves.)
YES
Replace I/O board.
NO
Replace PGU.

Troubleshooting (cont'd)

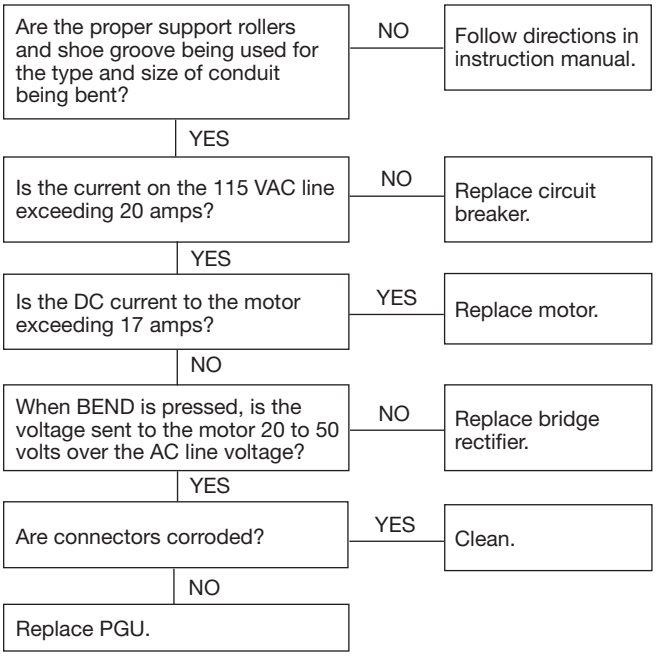
Won't unload – display on


Is the retention cam engaged with the roller support?
YES
Lower the roller support assembly.
NO
Is the roller support assembly completely disengaged?
NO
Lower the roller support assembly.
YES
Adjust the roller support limit switch.

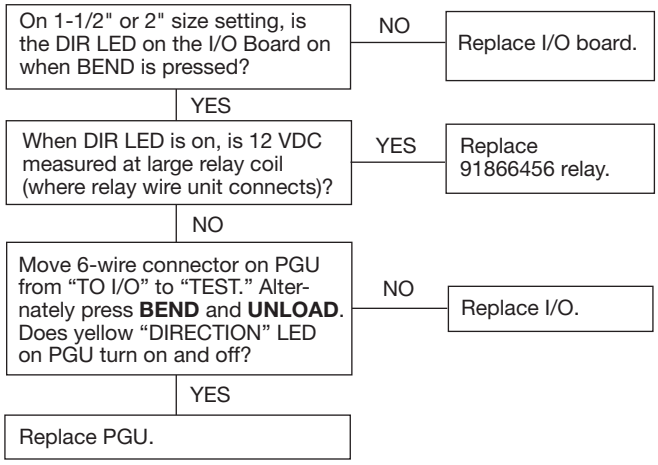
Won't stop



Trips circuit breaker

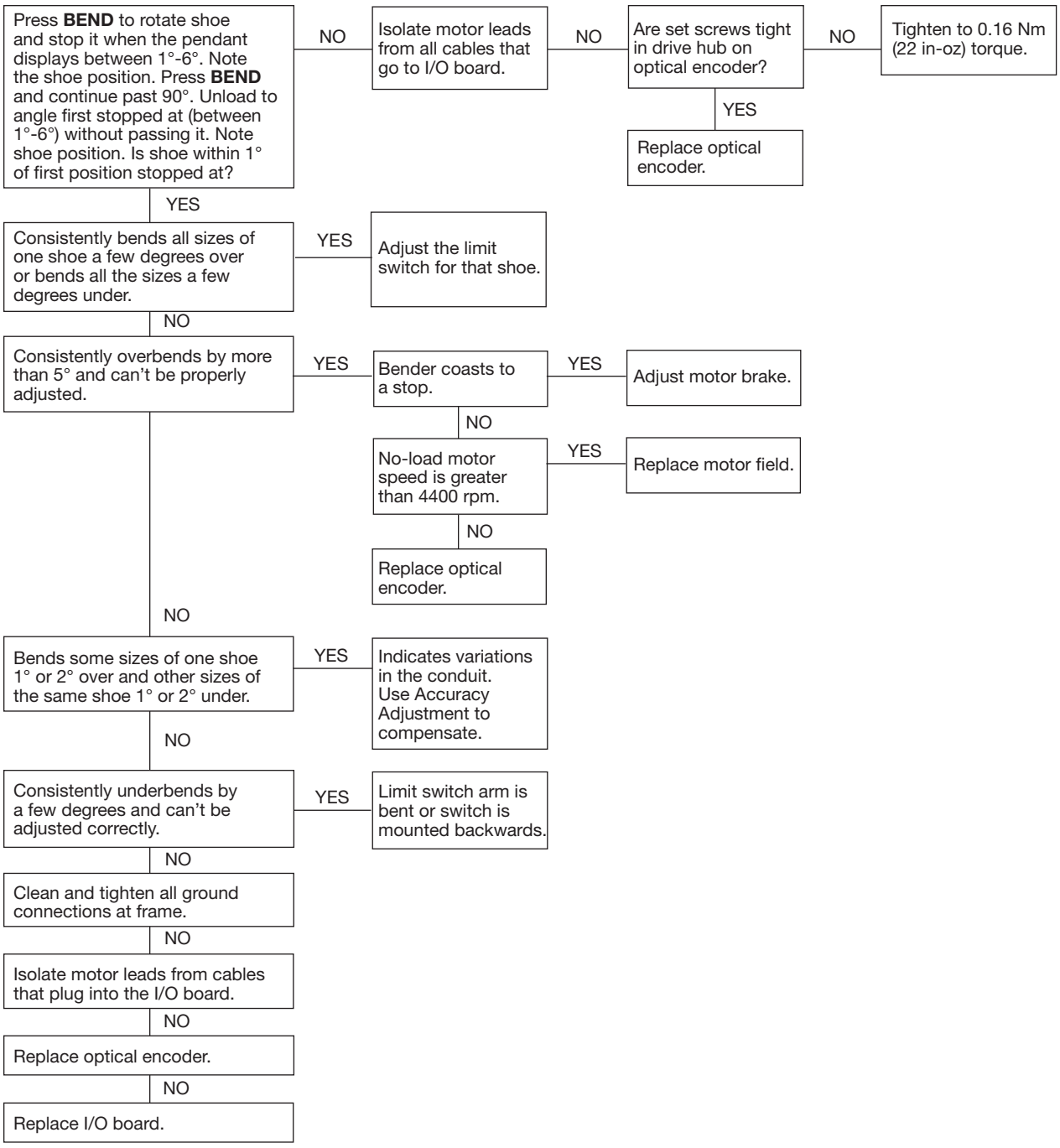

Are the proper support rollers and shoe groove being used for the type and size of conduit being bent?
NO
Follow directions in instruction manual.
YES
Is the current on the 115 VAC line exceeding 20 amps?
NO
Replace circuit breaker.
YES
Is the DC current to the motor exceeding 17 amps?
YES
Replace motor.
NO
When BEND is pressed, is the voltage sent to the motor 20 to 50 volts over the AC line voltage?
NO
Replace bridge rectifier.
YES
Are connectors corroded?
YES
Clean.
NO
Replace PGU.

Bender only runs in one direction


On 1-1/2" or 2" size setting, is the DIR LED on the I/O Board on when BEND is pressed?
NO
Replace I/O board.
YES
When DIR LED is on, is 12 VDC measured at large relay coil (where relay wire unit connects)?
YES
Replace 91866456 relay.
NO
Move 6-wire connector on PGU from "TO I/O" to "TEST." Alternately press BEND and UNLOAD. Does yellow "DIRECTION" LED on PGU turn on and off?
NO
Replace I/O.
YES
Replace PGU.

Troubleshooting (cont'd)

Makes inaccurate bends


Press **BEND** to rotate shoe and stop it when the pendant displays between 1°-6°. Note the shoe position. Press **BEND** and continue past 90°. Unload to angle first stopped at (between 1°-6°) without passing it. Note shoe position. Is shoe within 1° of first position stopped at?
NO
Isolate motor leads from all cables that go to I/O board.
NO
Are set screws tight in drive hub on optical encoder?
NO
Tighten to 0.16 Nm (22 in-oz) torque.
YES
Replace optical encoder.
YES
Consistently bends all sizes of one shoe a few degrees over or bends all the sizes a few degrees under.
YES
Adjust the limit switch for that shoe.
NO
Consistently overbends by more than 5° and can't be properly adjusted.
YES
Bender coasts to a stop.
YES
Adjust motor brake.
NO
No-load motor speed is greater than 4400 rpm.
YES
Replace motor field.
NO
Replace optical encoder.
NO
Bends some sizes of one shoe 1° or 2° over and other sizes of the same shoe 1° or 2° under.
YES
Indicates variations in the conduit. Use Accuracy Adjustment to compensate.
NO
Consistently underbends by a few degrees and can't be adjusted correctly.
YES
Limit switch arm is bent or switch is mounted backwards.
NO
Clean and tighten all ground connections at frame.
NO
Isolate motor leads from cables that plug into the I/O board.
NO
Replace optical encoder.
NO
Replace I/O board.

Troubleshooting (cont'd)

Accuracy Adjustment

Due to variations in conduit, you may notice that the bender consistently over- or underbends a particular size and type of conduit. Programmed adjustments can be made to compensate for over- and underbending conduit. Each size and type of conduit can have a unique adjustment ranging from plus 9 degrees to minus 9 degrees.

Standard Pendant

1. Press and hold **CLEAR**, and then press and hold **BEND** until "Pr" is displayed.
2. Use the side switches to select the size and type of conduit to compensate. The display shows the current adjust value ("0" is factory default).
3. Compensate the angle:
   - Press **ANGLE SELECT** ▲ to increase the bend to compensate for underbending.
   - Press **ANGLE SELECT** ▼ to decrease the bend to compensate for overbending.
   - Press **CLEAR** to reset the compensation to the factory default ("0").
4. Press **BEND** to save the adjust angle and exit the adjust mode.
   - The bender retains the new adjust value even if power is turned off.
   - The only way to change the adjust value is to repeat this procedure.
   - The pendant displays "oP" as it returns to operating mode.

Deluxe Pendant

1. Press **RESET**.
2. Press the 0 key three times. "PROGRAMMING MODE" appears on the display.
3. Key in the desired size and type of conduit to compensate. The display shows the current adjust value ("0" is factory default).
4. When the display prompts "ENTER NUMBER OF DEGREES (USE • FOR NEGATIVE)," use the numerical keys to enter a number from **0** to **9**. Use the • **(decimal)** key to toggle the negative sign.
   - Enter positive numbers to increase the bend to compensate for underbending.
   - Enter negative numbers to decrease the bend to compensate for overbending.
   - Press **CLEAR** to reset the compensation to the factory default ("0").
   - Press **RESET** to exit the adjust mode without changing any values.
5. Press **ENTER** to save the adjust angle and exit the adjust mode.
   - The bender retains the new adjust value even if power is turned off.
   - The only way to change the adjust value is to repeat this procedure.

Note: Once in the adjust mode, the pendant can display any compensation value by selecting the size or type. However, only the values of the last size and type viewed are saved to memory when exiting adjust mode.